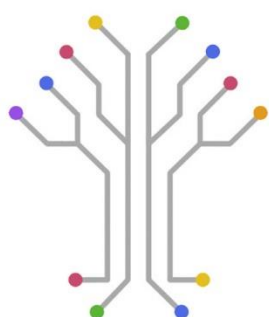


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2nd International Online  
Scientific Conference  
ICT in Life

Forging Tomorrow

CONFERENCE  
PROCEEDINGS

Editors:

Ivana Đurđević Babić, Vjekoslav Galzina and Anica Bilić



Sveučilište Josipa Jurja Strossmayera u Osijeku  
**Fakultet za odgojne  
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Conference *ICT in Life*  
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## **Preface**

With the same goal as the first conference, the second International Online Scientific Conference *ICT in Life* took place on May 17, 2024 with the conference theme *Forging Tomorrow*. The conference brought together researchers, experts and practitioners of information and communication technology and stimulated knowledge sharing, promoted innovation and contributed to both global development and local community development.

The conference attracted the attention of the academic community and other interested stakeholders as their presence at the conference offered diverse perspectives and a wealth of experiences. The 2nd International Online Scientific Conference *ICT in Life* brought together 94 participants from 14 countries who had the opportunity to network and collaborate through 49 presentations and participation in discussions that offered an international perspective on current ICT-related topics. However, the authors of the 23 articles published in this conference proceedings focused on educational topics and issues related to ICT use. As they primarily considered the use of ICT in empowering teachers as well as future teachers and relied on their perspectives, they did not neglect the role of teachers as pillars of the education system and initiators of all change.

It is important to point out that all papers have undergone the demanding peer review process, which was conducted according to the rules of double-blind anonymous peer review. For this reason, we express our appreciation to all the reviewers as well as the authors for their hard work, passion and commitment that contributed to the quality of the proceedings. Although the authors engaged their own English proofreaders and provided the editors of this conference proceedings with signed statements of proofreading from their proofreaders, which certainly helped to improve the stylistic and linguistic quality of the texts themselves and to ensure that each part of the conference proceedings was thoroughly checked, a final English proofreading of the entire collection was also carried out to ensure a consistent tone of the conference proceedings.

Editors

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## **Advancing Sustainability in IT Consulting: Introducing a Circular Economy Maturity Model**

Larissa Koch de Souza and Martin Engstler  
Stuttgart Media University, Hochschule der Medien, Germany

### **Abstract**

The topic of sustainability is becoming an increasingly important challenge in the IT sector for the coming years. Consequently, the implementation of a circular economy (CE) will be of importance in enabling the IT sector to become more sustainable. Moreover, translating CE principles into actionable strategies represents a significant challenge for IT consulting firms, which assist IT service companies in achieving their sustainability objectives. As a preliminary step towards the implementation of a CE approach, a bespoke Circular Economy Maturity Model was developed for the use within IT consulting companies. Building upon the foundational research presented in prior work, which includes a comprehensive systematic literature review or SLR for short and insights from an expert workshop, this research paper examines a model for the practical application of CE principles within IT service companies. The model identifies five clusters of maturity, as well as key action areas, to be measured and improved: 'Ecosystem', 'External Influences', 'Corporate Management', 'IT & Digitalisation' and 'Circular Strategy.' A systematic grading system enables organisations to assess their current 'CE maturity level' and identify strategies for enhancing their level through recommendations towards proactive sustainability practices. Consequently, the CE maturity level can be enhanced incrementally in order to establish a comprehensive circular strategy.

The aforementioned approach exemplifies a model for driving sustainable transformation, thereby contributing to a greener and more economically resilient future. The model, the measuring tool and the proposed CE maturity levels can be transferred to other application fields in the service sector with a view to improving business performance by reflecting sustainable development goals.

*Keywords:* Circular Economy, IT Consulting, Maturity Model, Sustainability

## Introduction

The global economy and the natural environment are undergoing significant changes, which are affecting a range of sectors, including information technology (IT), where sustainability concerns are becoming increasingly urgent (Cagno et al., 2021). Initiatives such as the European Green Deal reflect governmental efforts to address these challenges (Camón Luis & Celma, 2020). Nevertheless, doubts remain as to whether ecological objectives can be efficiently aligned with economic incentives in business practices. One promising response is the implementation of CE principles, which emphasise restoration, reuse, and regeneration within companies at a local level (Ellen MacArthur Foundation, 2015; Ellen MacArthur Foundation, 2013; Geissdoerfer et al., 2017). Despite a substantial body of literature on CE, its application within the IT service industry remains underexplored (Cagno et al., 2021). This paper seeks to address this gap by proposing a Circular Economy Maturity Model or CEMM for short for measuring and advancing the sustainability of IT service companies. The findings and proposed model provide a practical guide for IT consulting companies and establish the foundation for sustainable activities through the support of IT consulting. This research paves the way for further investigation into sustainable transformation, which could be applied to other areas of the service sector relevant to the development of actionable CE strategies.

## Classification of Circular Economy for IT Consulting

In previous research, CE has been defined in accordance with seven characteristics, namely: (1) circular production flow, (2) regeneration by design, (3) systemic thinking, (4) integration of economy, ecology and social aspects, (5) circular business model innovation, (6) slowing/closing/narrowing strategies, and (7) introduction of R-strategies (Koch de Souza, 2023). However, one of the main and most commonly presented characteristics of CE is the integration of *economic, ecological, and social effects* (Rosa et al., 2019; Upadhyay et al., 2021). The overarching goal is the integration of positive effects derived from all three areas (Koch de Souza, 2023). The principal advantage of CE as a model resides in the regeneration of its approach, minimizing (waste) resources and reducing emissions (Mhatre et al., 2021). Resources are utilised more efficiently, leading to reduced overconsumption, waste, and emissions (Fogarassy & Finger, 2020; Kulkarni & Pathak, 2023; Ellen MacArthur Foundation, 2019). Furthermore, CE also enhances resilience against environmental risks, reduces energy costs, decreases dependency on suppliers, and lowers environmental taxes and is thus conferring economic benefits (Antikainen et al., 2018; Korhonen et al., 2018; Rosa et al., 2019).



The most commonly identified challenge in the implementation of CE is the lack of awareness regarding its relevance (Koch de Souza, 2023). The regeneration and environmental context of CE is transient and based on dynamic processes, which in turn necessitate social dynamics and a willingness to change (Korhonen et al., 2018). External environmental factors and limitations also serve to impede the implementation of CE (Korhonen et al., 2018; Khan et al., 2021a). Indeed, over the years CE has been the subject of growing and business-oriented scrutiny. The European Circular Economy Package introduced in 2015, saw government involvement commit to CE implementation through an action plan (European Green Deal, 2023; Fogarassy & Finger, 2020). Nevertheless, an examination of the application of definitions and strategies to business areas such as the IT service industry reveals deficiencies in the existing research (Lieder & Rashid, 2016).

This particular field of application represents a primary area of interest for IT consulting companies. The development of a CE maturity model allows IT consultants to assist their clients in achieving economically advantageous sustainability. To date, the digital-leading companies in this sector have demonstrated a clear recognition of the relevance of CE (Neligan et al., 2023). This is driven primarily by the need to secure competitiveness to shift customer demand towards circular services (Neligan et al., 2023). Therefore, the acquisition of expertise and a method for measuring and successfully implementing CE ensure that a company occupies a leading position in the market with regard to sustainable (IT) transformation.

Additionally, it must be noted that the IT service industry itself is a contributor to negative environmental impacts (Figge & Thorpe, 2023; Ruda & Pukas, 2022; Bocken et al., 2023). It is therefore evident that a sustainable business approach is of particular necessity. It is encouraging to note that the industry context of IT consulting offers significant potential for transparent data pathways (Antikainen et al., 2018; Khan et al., 2022; Neligan et al., 2023; Khan et al., 2021b). Furthermore, the increased use of digital technologies serves to amplify the impact of CE (Ramesohl et al., 2022; Khan et al., 2022; Uçar et al., 2020). The four most relevant technologies for the implementation of CE as an IT consulting company are (1) blockchain, (2) artificial intelligence, (3) cloud solutions, and (4) the Internet of Things (Koch de Souza, 2023).

## **Methods**

The research of this paper aims to address the question of which CE maturity levels should be evaluated within the context of IT service companies and how IT consulting companies can undertake actions to assist the assessed companies in achieving high levels of

CE. In order to respond to the research question, an evaluation of the current state of the literature has been conducted. The methodology involved a systematic literature review (SLR), which can be classified as follows: (1) establishment of a fundamental concept of CE; (2) identification of bespoke applications of CE to the IT service industry; (3) analysis of implementation requirements and possibilities for CE (Koch de Souza, 2023). The method of the SLR was selected for its suitability in identifying existing implementation approaches of CE. The results provide a comprehensive summary of the current state of CE in the IT industry (Koch de Souza, 2023). Following the SLR, a focus group was proposed and conducted as a means of verifying the literature results from an industry perspective, prior to the development of the maturity model.

The focus group method represents a research approach that provides researchers with in-depth insights into the views, opinions and experiences of a group of participants on a specific topic (Bell et al., 2019). The study employs a thematic approach to group interviews facilitating an in-depth discussion and interaction among various experts on the subject of SLR findings (Bell et al., 2019). Preparation for a focus group involves clarifying the framework, selecting participants and planning discussion blocks (Creswell, 2018). The conduct of a focus group unfolds three stages: (1) introduction, (2) discussion, and (3) summary (Bell et al., 2019). The discussion constitutes the primary means of gathering information and was conducted in a relatively free format, with prepared discussion blocks serving as a guide (Bell et al., 2019). Subsequently the data is subject to an evaluation and verification process, which entails the recording, transcription, and the application of a coding system (Bell et al., 2019). It is crucial to consider the criteria of reliability, replicability, and validity in order to guarantee the quality of the results (Bell et al., 2019).

The focus group for the research presented in this paper was carried out within the conduct of a two-hour expert workshop, which involved the contributions of consultants from the technology and management consulting company Campana & Schott. The workshop aimed to examine the preliminary findings of the SLR regarding the implementation of CE in IT service companies and complement them with industry insights. The workshop was conducted as a synchronous online session utilising the Microsoft Teams platform. The proceedings of the workshop were recorded in real time using Mural boards, thus ensuring that all participants had access to the documentation throughout the session. The group of participants was composed of experts from different relevant job profiles within the IT consulting firm Campana & Schott. Four experts were selected based on their roles and expertise in the following fields: IT sustainability, IT project management, IT transformation management and IT strategy

implementation (see Appendix 1). With regard to the programme, the workshop started with an introduction to the focus group method, followed by the participants' own introductions and an overview of the CE approach in the context of IT consulting. The discussion focused on specific aspects of CE implementation. The prepared discussion topic blocks were based on the prior SLR findings and included the following topics: ecosystem, external influences, circular organizational strategy, circular IT strategy, digitalisation, infrastructure standards, new technologies, and data management. With regard to each topic block, the participants were invited to engage in a discussion concerning their understanding of the topic, which involves potential measures, the relative importance of different factors, the feasibility of proposed solutions, and the criteria for assessment. The discussion was documented in real time and subsequently summarised on the Mural board. The key points of discussion were transcribed after the workshop (see Appendix 2). The results were subjected to coding, analysis and evaluation using code clusters (see Appendix 3) in order to establish the foundation for the development of a Circular Economy Maturity Model for IT consulting companies to use with their IT service customers.

Based on the results and synthesis of the SLR and the focus group findings, an initial maturity model was developed. A maturity model is a framework that is employed to evaluate the level of maturity or development of an organisational entity or process (Becker et al., 2009). It is defined as a sequence of maturity levels for a specific class of objects, outlining an expected developmental trajectory from an initial stage to full maturity (Becker et al., 2009). The primary objective of a maturity model is to assess the current state and position of the objects under consideration within an enterprise, identify areas for improvement, and monitor the progress of improvement efforts (Altuntas & Uhl, 2016). A key feature of maturity models is the concept of continuous improvement across the spectrum of maturity levels (Wademan et al., 2007; Altuntas & Uhl, 2016). The development of the maturity model for the context of CE implementation through IT consulting was guided by the methodical approach outlined by Becker et al. (2009), as well as the example set by the Digital Maturity Model introduced by Berghaus & Back (2016) (see Fig 1).

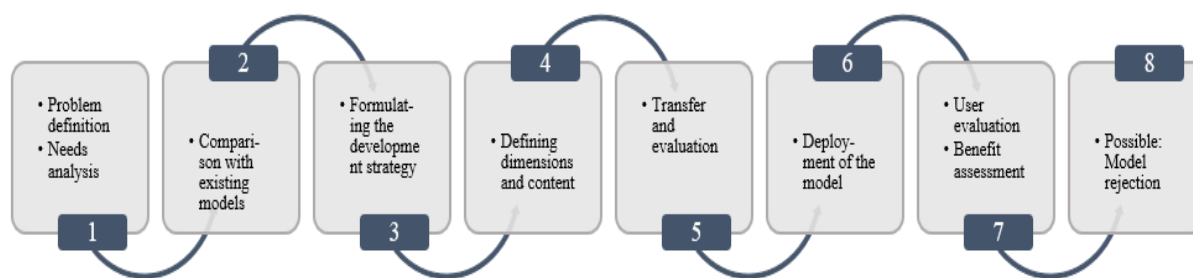


Figure 1. Development of maturity models (based on Becker et al., 2009)

The initial phase *defining the problem*, must be addressed and identified in collaboration with the target audience, reflecting their specific needs. For the context of this paper and research, the initial problem statement pertains to the development of the maturity model itself, as well as the practical application of the model through the services of IT consulting companies. The objective of the model is to categorise IT service companies according to their existing level of CE implementation, and to provide guidance on CE implementation through the provision of IT services. The second phase of the CE Maturity Model development process involved a comprehensive *analysis and comparison* of existing models to ascertain their necessity. It was observed that there are currently no circular (maturity) models specifically tailored to the context of IT services and IT consulting. Although there are numerous individual strategies and frameworks that support generic CE implementation (e.g., R-Strategies, ReSOLVE; EMAF, 2015), the necessity for a dedicated maturity model on the subject became evident. In the third phase, the CE Maturity Model's *iterative development strategy* was defined, and the model structure was planned. This involved the incorporation of the findings from the previously conducted SLR and the insights gained from the earlier focus group. In summary, the results of the SLR, together with the findings from the focus group, define the key areas of action and build the content base of the CE maturity model. The comparison between the SLR and the focus group revealed a substantial overlap in content across the action areas and content, with variations in emphasis and execution (s. App. 4). This led to a selection of five final action fields for the CE Maturity Model: (1) *Ecosystem*, (2) *External Influences*, (3) *Company Management*, (4) *IT & Digitalisation* and (5) *Circular Strategy*.

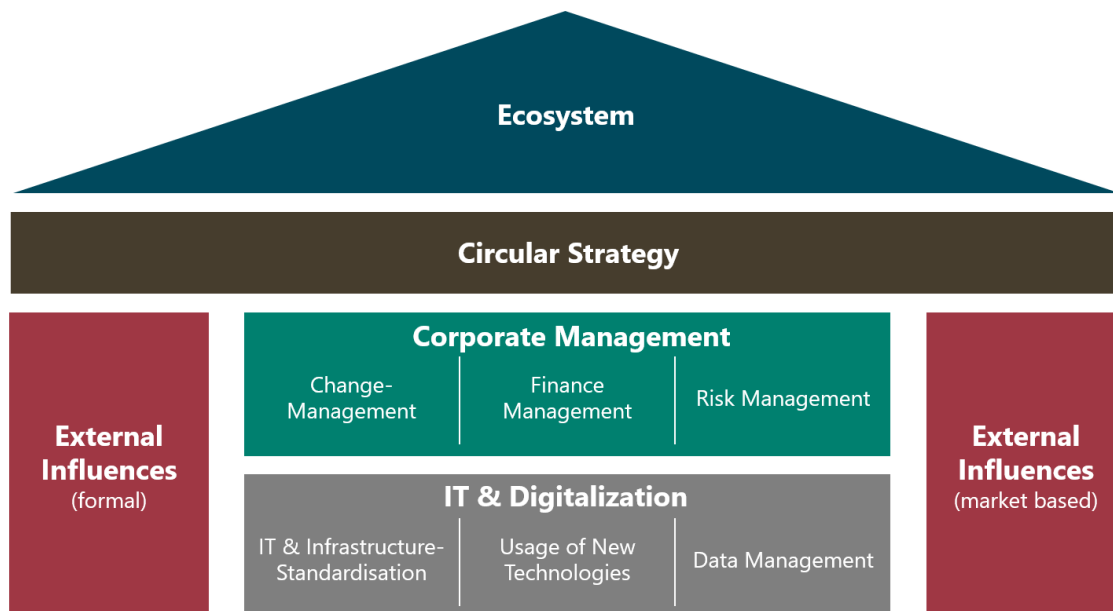
Moreover, the CE Maturity Model dimensions were determined based on the findings of the SLR, the results of the focus group, and maturity model method outlined by Becker et al. (2009), the CE Maturity Model dimensions could be determined. Five maturity dimensions were identified: (1) inactive, (2) reactive, (3) active, (4) established and (5) proactive. The

results of the analysis of both the content and structure of the CE Maturity Model are presented in the following sections.

## Results

### *Action Areas of the Maturity Model*

The action areas form the basis and main content of the CE Maturity Model. Each area represents a distinct aspect influencing CE implementation in IT service companies. The final five fields of action are illustrated in a diagram, with the **Ecosystem** forming the framing roof, **Circular Strategy** forming the underlying foundation, **External Influences** forming the guiding outer pillars and **Company Management** and **IT & Digitalisation** forming the company-internal pillars (s. Fig. 2).



*Figure 2. Action area overview of the CE Maturity Model*

Each action area is further subdivided into specific activities, which are then assessed using Likert scales for the purpose of evaluating the overall maturity dimension. The final definitions, activities, and weighting of each action area are as follows:

**Ecosystem:** The concept of the ‘ecosystem action area’ is based on the understanding that a company's entire ecosystem must engage in comprehensive cooperation and collaboration if it is to successfully implement CE strategies. It is crucial to recognise that the implementation of CE cannot be viewed in isolation, but must be considered from a holistic perspective that encompasses the internal and external dimensions of the organisational ecosystem. It is imperative that collaboration and coordination with all stakeholders in the ecosystem, including

suppliers and partners, be prioritised. It is of particular importance to ensure transparent communication and the creation of acceptance. This requires the establishment of a consensus regarding the CE theme which must be conveyed both internally and externally within the organisation. In order to facilitate the implementation of CE, it is essential that IT consulting companies adopt a unified approach to communicating the CE theme to all relevant stakeholders. It is also imperative to identify and analyse the stakeholders within the ecosystem, which is why the creation of a stakeholder map and the implementation of targeted stakeholder management are recommended. It is similarly recommended that IT consulting companies conduct regular reviews of communication processes with their clients, as this will facilitate the long-term implementation success of CE.

With regard to the feasibility of implementing CE activities within the *Ecosystem* action area in terms of both weight and realistic execution, the focus group concluded that the defined criteria in this are a viable proposition. However, in the SLR, it was found that consistent collaboration across an ecosystem for full-fledged CE among all parties was not a realistic expectation. Nevertheless, the SLR also confirms that the fundamental level of required communication and collaboration within an ecosystem for CE implementation within the central IT sourcing company is feasible and can be achieved through the implementation of effective communication strategies and the stakeholder management. In conclusion, the *Ecosystem* action area was assigned a moderate-low weight in the overall context of CE implementation with a weight of 10% for the total maturity model assessment. It represents the overarching framework for CE implementation, providing a unifying structure for all other action areas. As previously stated, the current-target state comparison within the CE Maturity Model assessment is conducted using Likert scales. Consequently, 10% of the Likert scales are from the *Ecosystem* action area. Out of a total of 40 Likert scales, which are employed in the assessment, with four statements derived from the identified key aspects in this action area. The final statements address the following topics: accessible ecosystem understanding, communication in the ecosystem, collaboration towards common CE goals and active stakeholder management. The precise formulation of the Likert scale statements is outlined in Appendix 5.

***External Influences:*** The definition of the *External Influences* action area is based on two parts: formal external influences and market-related external influences. In the context of the SLR, the role of end consumers from IT service companies was identified as the primary market-related external influence. Conversely, the focus group primarily concentrated on general company-related resilience in response to market trends, competitive advantages, and

cost fluctuations. Furthermore, the pillar of formal external influences was identified in both the SLR and the focus group as a significant factor, with emphasis on regulations and the influence of the public sector. In particular, within the EU, it is necessary to consider not only the potential for subsidies but also the applicability of relevant guidelines.

The specific measures that an IT consulting company must take to achieve the circular target state of an IT service company are strongly oriented towards the existing guidelines of the EU. This includes, for example, the provision of a transparent presentation of one's own CE indicators. In particular, the European Sustainability Reporting Standards (ESRS) were identified as a key example in the focus groups, given that the ESRS proposals developed by the European Financial Reporting Advisory Group (EFRAG) were formally adopted as part of the Corporate Sustainability Reporting Directive (CSRD) on 31 July 2023 (European Commission, 2023). Especially ESRS E5 sets out reporting requirements pertaining to the utilisation of resources and CE, with a specific focus on materials and their circular use, as well as the potential for circular practices within a company (EFRAG, 2023). The implementation of the ESRS and analogous CE guidelines represents the major objective for CE in IT consulting.

Regarding the market-related aspects of *external influences*, there was a notable increase in customer acceptance of CE at the functional, emotional, and monetary levels. According to the experts participating in the focus group, a portfolio with these market-related demands is a prerequisite for the successful implementation of CE. The complexity of the external influences domain gave rise to a particularly robust exchange of ideas within the focus group. On the one hand, the implementation of formal guidelines and market-oriented alignment was perceived as straightforward, given that the guidelines are already predefined. Both forms of external influences were identified as very dynamic and never consistent. The required flexibility for meeting market-related and formal requirements was also reflected by the SLR, and thus, the action area *External Influences* is considered to have a moderate level of difficulty. In light of the aforementioned factors, as well as the considerable impact that external influences exert on CE implementation, this action area was accorded a high weighting by both the focus group and the SLR. The final weighting of the *External Influences* action area is 20%, thus encompassing eight assessment statements, which are queried using Likert scales (see Appendix 5). The statements revolve to the following topics: customer persuasion, adaptation to market trends, compliance with regulations and utilisation of incentives.

**Company Management:** The Company Management action area, as identified through both the SLR and focus group discussions, represents a key area of focus in terms of

understanding the structural elements of internal corporate governance and management practices. It encompasses topics related to change management, financial management, and risk management. The implementation of CE is contingent upon not only on technological advancement but also the fostering of internal acceptance, resilience and preparedness for circular approaches. The provision of specific measures by IT consulting companies typically encompasses the establishment of robust change management practices, with the objective of preparing and supporting employees through transformative initiatives. The importance of CE culture and CE-positive leadership is specifically emphasised.

Furthermore, effective financial management is essential for the realisation of the economic benefits of the CE concept and the mitigation of financial risks. It is recommended that IT consulting companies conduct cost analyses of current processes in comparison to circular alternatives and formulate cost optimisation strategies based on these findings. Additionally, effective risk management, which encompasses financial, strategic, and operational dimensions, is of particular importance in the IT service sector due to its intermediary position between IT manufacturers and customers.

Although the focus group did not directly address individual activities within the Company Management action area, it was acknowledged that topics such as change management and leadership culture provide the fundamental foundation for activities across other action areas. The findings of the SLR and focus group discussions indicate that risk management activities are particularly challenging. Given the moderate to challenging nature of implementing activities within this action area, coupled with their significant impact on CE implementation, a moderate-high weighting has been assigned to this area in the CE Maturity Model. This action area constitutes 15% of the overall CE maturity assessment, encompassing six assessment statements, the evaluation of which is conducted using a Likert scale. The statements address the following aspects: change management practices, leadership culture, employee acceptance, financially aligned CE management; risk management practices and the fostering a culture of CE (see Appendix 5).

**Information Technology & Digitalisation:** The action area of *IT & Digitalisation* places significant emphasis on digital transformation as a critical factor, delineating the prerequisites for CE implementation and functioning as an enabler for the concept. It is imperative that IT service companies must possess a robust digital foundation and leverage industry-specific advantages for CE implementation. Consequently, IT consulting companies are well positioned to assist with a range of activities, including the standardisation of IT and infrastructure standardization, the adoption of new technologies, and the management of data.



There is a significant degree of alignment between findings of the SLR and the insights gleaned from the focus group. The objective of digitalisation and infrastructure standards is to establish minimum benchmarks for modernisation and IT infrastructure. It is essential to establish a comprehensive overview of current standards and associated objectives, with a particular focus on quality requirements. This can be achieved by comparing the current state of infrastructure assets and the planned duration for which they are intended to remain in use. The adoption of new technologies is to be aligned with this approach, providing an overview of current technologies and assessing a company's status quo against emerging trends. The SLR identifies specific advantages of emerging technologies like blockchain, artificial intelligence (AI), and the Internet of Things (IoT), while underscoring the necessity for their integration only if they deliver tangible value for CE implementation. It is of relevance to analyse the flow of information and to guarantee the transparency of the data pathways in order to facilitate the implementation of CE. However, the focus group cautions against the current trend of data maximisation, which could have a detrimental impact on CE implementation. It is critical to manage data in a way that is both streamlined and scalable, particularly in the context of CE concepts. Consequently, IT consulting companies can facilitate CE implementation through the formulation of a targeted data strategy.

In general, all activities within the field of *IT & Digitalisation* must consider environmental conditions and the capabilities of IT service companies. It is not always the case that optimisation trends facilitate long-term CE implementation. This is due to the potential for such trends to have unintended consequences, including increased energy consumption and issues with scalability. Therefore, the *IT & Digitalisation* area is assigned a moderately challenging level with significant weight, reflecting its crucial role in supporting the particular industry context of this research. This key domain constitutes 30% of the assessment, encompassing twelve evaluation statements addressing CE infrastructure standards, IT utilisation, circular IT processes, technology adoption, strategic measurability, agility, data collection, innovation, data strategy, efficient management, scalability and transparent evaluation (see Appendix 5).

***Circular Strategy:*** The key action area of *Circular Strategy* serves as the foundational framework of the CE maturity model and is crucial for the long-term success of CE implementation. It consolidates the components and strategic objectives from the other four key action areas, thereby ensuring that CE principles are adequately embedded throughout the organisation. The adoption of a company strategy to the CE context is essential, which necessitates alignment between IT and business needs. The SLR advocates for the regular

alignment of business and IT activities, using the Strategic Alignment Model proposed by Henderson (1993).

Specific activities include the formation of a circular organisational strategy, the alignment of the current state with desired outcomes and the formulation of measurable goals. The formulation of a circular strategy is inextricably linked to the development of an effective IT strategy. This strategy must encompass the essential IT themes and be regularly synchronised with the overall objectives of the organisation. The implementation of measures to ensure this alignment includes the management of project portfolios, the conducting of consistent CE strategy reviews and the facilitation of communication. Furthermore, the focus group suggests implementation of a materiality analysis as a potential metric.

The focus group engaged in a rigorous examination of the *Circular Strategy* action area particularly with regard to the potential challenges associated with its implementation and the appropriate level of emphasis to be placed on it. Although the formulation of strategies is a well-established practice, the actual implementation, particularly within the CE context of IT service companies where such strategies haven't been tested, presents significant challenges. The attainment of a strategy formulation goal deemed feasible was rated as moderately attainable and assigned a moderate weight. Nevertheless, the SLR highlights the significance of well-formulated strategies with other action areas necessitating alignment with circular strategy concepts. Accordingly, a weight of 25% was assigned to this area within the CE Maturity Model, comprising ten Likert scale statements addressing strategy alignment of the strategy with environmental, economic, and social goals; measurable strategy objectives; transparency; business-IT alignment, regular review; impact analysis; integration of other action areas; support for Circular Business Model Innovation (CBMI) and strategic alignment with CE frameworks (see Appendix. 5).

### *Maturity Model Dimensions*

The development of the CE Maturity Model has identified the above five action areas, outlined above, described the associated activities and measures that IT consulting companies can assist with, and established the weighting of each action area relative to the others within the model. In order to evaluate the CE Maturity Model, a comparison was conducted between the desired and current states is conducted across 40 Likert scales, which span the five action areas. The evaluation form is comprised of four evaluation statements pertaining to the Ecosystem key action area (10%), eight statements related to External Influences (20%), eight statements concerning Corporate Management (15%), twelve statements regarding IT &

Digitalisation (30%), and ten statements related to Circular Strategy (25%). Once the evaluation evaluation form has been completed, the CE maturity dimension that the assessed IT service company has achieved is determined. The aforementioned maturity dimensions have been derived from the theory of the maturity model development in accordance with the examples provided by Glanze et al. (2021) and Schaltegger et al. (2012). In order to ensure a comprehensive range of maturity dimensions and an even distribution of point allocations across the scales, five distinct maturity dimensions were developed. The five levels of maturity are as follows: Inactive, Reactive, Active, Established and Proactive. Each maturity dimension describes the outcome of the desired versus the current state comparison for an IT service company upon completion of the evaluation form, thereby characterising the CE maturity level of the IT service company. The points assigned via Likert scales within the evaluation form are evenly distributed in a manner that is consistent with the desired distribution across the various maturity dimensions. Each dimension is achievable in increments of 40 points. The specific dimensions and their associated criteria are outlined in Table 1.

*Table 1. Maturity model dimensions of the CE Maturity Model*

<b>Maturity Dimension</b>	<b>Likert scale result</b> (Total: 200 points)	<b>Description maturity dimension criteria</b>
<i>Inactive</i> (0-20%)	0 to 40 Points	<ul style="list-style-type: none"> <li>- No strategic interest in CE</li> <li>- Linear business models &amp; processes</li> </ul>
<i>Reactive</i> (21-40%)	41 to 80 Points	<ul style="list-style-type: none"> <li>- Occasional, circular activities in response to impulses</li> <li>- No active interest or engagement in the CE field</li> </ul>
<i>Active</i> (41-60%)	81 to 120 Points	<ul style="list-style-type: none"> <li>- Circular potentials identified</li> <li>- Circular strategy integrated into CE-compatible development concept</li> <li>- Application of CE-specific strategies</li> <li>- Circular processes depicted in the business model (through individual strategies)</li> </ul>
<i>Established</i> (61-80%)	121 to 160 Points	<ul style="list-style-type: none"> <li>- Infrastructure and processes adapted to CE</li> <li>- Monitored CE goals and public reporting of results</li> <li>- Fully circular processes and business model orientation</li> <li>- Application of CE frameworks</li> <li>- Circularity throughout the entire ecosystem</li> </ul>
<i>Proactive</i> (81-100%)	161 to 200 Points	<ul style="list-style-type: none"> <li>- CE activities on social, economic, and ecological levels</li> <li>- Proactive engagement across the entire ecosystem</li> <li>- Continuous alignment and improvement of CE implementation</li> <li>- Leading role in CE activities</li> <li>- Anchored, circular business model &amp; potential CBMI</li> </ul>

In conclusion, the five maturity dimensions collectively reflect the extent to which an IT service company has implemented CE. These comprise the maturity levels of the CE Maturity Model for IT service companies, based on the previously outlined action areas and activities. This CE Maturity Model presented here serves as a guideline for companies seeking to align and implement their identified action areas in a circular manner. Further discussion and interpretation of the model's problem-solving capability, as well as its alignment with research objectives and hypotheses, will be presented in the following discussion and conclusion.

## **Discussion**

This research project aimed to examine the central theme of developing a maturity model for implementing CE in IT service companies in a comprehensive manner. The objective was to evaluate the current levels of CE maturity and to identify potential avenues for IT consulting companies to facilitate the attainment of higher goals in this domain through the utilisation of the maturity model. It was initially observed that there was a dearth of bespoke CE implementation support for the IT service industry. A sequential mixed-method approach (SLR, focus group and maturity model theory) was employed in order to develop the CE Maturity Model for IT service companies. The action areas presented in the model serve as a guide for the implementation of the CE in IT service companies. While all action areas are of equal importance, their impact on the success of CE implementation varies. Accordingly, the action areas were assigned weights based on their relevance and influence with respect to comprehensive CE implementation. The final classification of an IT service company's maturity level is based on a comparison between the current state of the action areas and the desired state. For this purpose, five distinct maturity dimensions were developed, ranging from a state of inactivity to one of proactive engagement. The assessment of CE maturity levels in IT service companies employs a Likert scale-based evaluation sheet, which is both scientifically and practically sound. The final evaluation sheet, together with the recommended actions and measures derived from the CE Maturity Model's action areas, will assist IT consulting companies in providing sustainable consulting services to their customers.

The presented research and its findings offer a tangible, applicable maturity model for assessing CE in IT service companies, thus making a significant contribution to both research and practice. Nevertheless, a critical examination of the findings and an exploration of potential avenues for future research are essential. In terms of limitations, it is notable that the research was conducted exclusively within the context of IT service companies. This specialisation

constrained the generalisability of the final model to the specific context of this industry sector. Nevertheless, this focus was pivotal for attaining a comprehensive understanding of the CE issues and developing a tangible CE maturity model. The research indicated that the applied SLR and focus group methods were successful within the IT service context, suggesting that similar research fields within the broader service industry may yield comparable results. All the same, this remains a conjecture that offers promising avenues for future research.

It is imperative to consider the constraints of the SLR and focus group methodologies, as outlined in this and prior studies. In particular, although the focus group provided valuable insights and augmented the research, it was constrained to the context of Campana & Schott, which limited the generalisability of the findings and incorporated some company-specific observations. While these limitations were taken into account in the results of the developed CE Maturity Model, they should also be considered for future research. For example, the role of the moderator may be less controlled in a focus group than in an individual interview (Bell et al., 2019). Additionally, group dynamics may influence the results. These are constraints of the chosen method that need to be acknowledged. Furthermore, the method may not be appropriate for all research contexts and could introduce biases resulting from group dynamics and participants' subjective perspectives (Bell et al., 2019). Nevertheless, the focus group method represents an efficient means of generating qualitative data and has proven to be suitable for this field of research.

In light of the accelerated pace of innovation in this field, future research must address the rapid developments that are occurring. Both the IT industry and the CE concept are undergoing significant changes with regard to standards, guidelines and new developments. This was demonstrated during the development of the CE Maturity Model in this work, during which new sustainability guidelines were released during the research process. Similarly, the rapid pace of development of solutions and services in the IT industry must be considered. It is therefore recommended that the CE Maturity Model be aligned with current standards and guidelines on a regular basis. This is of particular importance with regard to activities and measures within the action areas of *External Influences* and *IT & Digitalisation*, where the most rapid changes are observed.

## **Conclusion**

The developed CE Maturity Model plays an invaluable role in evaluating the status of CE implementation in IT service companies and in identifying potential avenues for improvement. It would be beneficial for future research to focus on enhancing the

generalizability of the research field to the broader service industry. It is recommended that the research design presented in this work be followed, with due consideration of the limitations of the applied methods. In light of the rapid evolution of both IT and CE research, it is imperative to conduct regular reviews and updates to ensure the CE Maturity Model remains aligned with the latest developments.

This work represents a significant advance in the implementation of CE in IT service companies. The insights gained for both IT service companies and IT consulting, as well as the final CE Maturity Model outcome and suggestions for future research, contribute to the advancement of the transformation of this industry towards a more sustainable and circular direction. It is recommended that the CE Maturity Model is integrated into the sustainable, transformation-specific services offered by IT consultancy firms (such as Campana & Schott and others in that field of consulting). This will provide both customers and the consultancy firms itself with value and new solutions, ultimately leading to deeper insights into the model's usability within the IT consulting industry. In conclusion, the CE Maturity Model represents a long-term, value-adding expansion of an IT consulting company's portfolio, facilitating a more sustainable yet economically secure future for both the consultancy and clients within the IT service industry.

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## Appendices

Appendix 1: Overview of the focus group experts

Expert	Role	Expertise	Touchpoints to the research topic
E1	Expertise Lead	Expertise Lead IT Sustainability	Direct sustainability work in digital transformation customer projects
E2	Managing Consultant	Expertise Lead IT Strategy Implementation	Indirectly within IT strategy conception projects
E3	Manager	Expertise Lead IT Project Management	Indirectly through the sustainability goals of our own clients, which can impact projects
E4	Consultant	IT Project Management	Research work in the field of sustainable digitalization

Appendix 2: Mural board overview of the focus group workshop

The mural board overview consists of several interconnected cards:

- Einführung (15min):** Contains introductory text and diagrams.
- Überblick Circular Economy Modell (25min):** Features a diagram of the Circular Economy Model and a table with 5 rows and 2 columns.
- Brainstorming Teilbereiche (70min):** A central section with 7 cards:
  - Ökosystem (10min):** Table with 5 rows and 2 columns.
  - Außeninflüsse (formal / marktbedingt) (10min):** Table with 3 rows and 2 columns.
  - Zirkuläre Organisationsstrategie (10min):** Table with 3 rows and 2 columns.
  - Zirkuläre IT-Strategie (10min):** Table with 3 rows and 2 columns.
  - Digitalisierungs- & Infrastrukturstandards (10min):** Table with 3 rows and 2 columns.
  - Neue Technologien (10min):** Table with 3 rows and 2 columns.
  - Datenmanagement (10min):** Table with 3 rows and 2 columns.
- Abschluss (10min):** Includes a 'Thank you!' card and an 'Offene Fragen / Anmerkungen' card.

Appendix 3: Transcription and analysis of the focus group (excerpt for topic block *Ecosystem*)

Topic block	Guiding questions (subs from Miral)	Consensus achieved from the group	Diversity of the group	Open, unresolved discussion points	Quotes	Observations regarding group interaction	Result codes	
A. Ecosystem	<p>Guiding questions (subs from Miral)</p> <p>1. Understanding and implementation relevant aspects</p> <p>2. Measures</p> <p>3. Measurements</p> <p>4. Classification of the difficulty level (1 to 5)</p> <p>5. Classification of weighting</p> <p>6. Proposed evaluation statements</p>	<p>Identification and analysis of stakeholders must be considered during implementation.</p> <p>Give the topic a stage through increased visibility within and outside the company</p>	<p>x</p> <p>x</p>	<p>x</p> <p>x</p>	<p>"To ask ones to which are the relevant stakeholders that have an influence on the ecosystem and the implementation of the topic. The topic is being discussed and made visible on various platforms, both within and outside the company." (E3)</p> <p>"You cannot communicate and pass on anything if it is not initially clear what the understanding of the exact topic is." (E2)</p> <p>"We look at the short definitions. I would not include the point [of hardware inventory and data according to the removal of EI] under the ecosystem, but assign it to IT and IT partially in the organizational strategy and thereafter. It is not a subordinated point in the infrastructure, and I understand ecosystems as the environment of all those who are interested in the circular economy and how we are still not able to quantify what change, needs, and obligations the different groups have." (E1)</p> <p>"I believe that the obligations and interests of the stakeholders are very exciting at this point in order to be able to fill the topic in a targeted, organized manner." (E2)</p>	<p>Clear, verbally expressed agreement</p> <p>Clear, verbally expressed agreement</p>	<p>A11</p> <p>A12</p>	
		<p>Understanding, for example, through an inventory of ICT and hardware as a broader analysis of the entire ecosystem. Dissent regarding the inclusion of the topic in the sub-module 'Ecosystem'.</p>	<p>x</p>	<p>x</p>	<p>To what extent are framework conditions established at this point or only "communicated" and then created in organizational strategy?</p>	<p>"Mechanisms in the delineation of the building blocks -&gt; when does building block X begin, what is primarily assigned to building block Y."</p>	<p>A13</p>	
		<p>One using a unified understanding of the topic</p>	<p>x</p>	<p>x</p>	<p>There is no text provided to translate. Please provide the text to be translated.</p>	<p>"I understand ecosystems as the environment of all those who are interested in the circular economy and how we are still not able to quantify what change, needs, and obligations the different groups have." (E1)</p> <p>"We believe that the obligations and interests of the stakeholders are very exciting at this point in order to be able to fill the topic in a targeted, organized manner." (E2)</p>	<p>Clear, verbally expressed agreement</p>	<p>A14</p>
		<p>Ecosystems are to depict the environment of all those who are interested in the Circular Economy.</p>	<p>x</p>	<p>x</p>	<p>There is no text provided to translate. Please provide the text to be translated.</p>	<p>"We still need to be able to quantify what change, needs, and obligations the different groups have." (E1)</p> <p>"I believe that the obligations and interests of the stakeholders are very exciting at this point in order to be able to fill the topic in a targeted, organized manner." (E2)</p>	<p>Clear, verbally expressed agreement</p>	<p>A15</p>
		<p>Define and quantify the obligations and interests of the stakeholders.</p>	<p>x</p>	<p>x</p>	<p>There is no text provided to translate. Please provide the text to be translated.</p>	<p>"To create a unified understanding, one could (do) surveys to make the whole thing understandable." (E4)</p> <p>"One can also make the (same) understanding of the ecosystem possible by looking at whether the company has a website on the topic, where they define it." (E1)</p> <p>"And it doesn't have to be just a website, but a general formulation of the topic. And it can also refer to this as a basis for a unified understanding." (E2)</p> <p>"Clearly, the stakeholder map or stakeholder quantification [...] On a general level, for example, one can see what the various groups are." (E1)</p> <p>"It is always difficult when you are still at the first point and others are still to come. I would have said now that this is easier to implement than other topics." (E2)</p> <p>"I would rather go low with the ecosystem component to give more weight to the lower topics." (E1)</p>	<p>Clear, verbally expressed agreement</p>	<p>There is no specific meaning or context for the text "A21" in German, so it cannot be translated.</p>
		<p>A unified website formalization/definition of the topic as a measure</p>	<p>x</p>	<p>x</p>	<p>There is no text provided to translate. Please provide the text to be translated.</p>	<p>"A common understanding was established among the stakeholders." (E1)</p> <p>"The things you just described is the foundation for us (it is described and accessible), and therefore, still here to make sure it gets through to people's minds." (E2)</p> <p>"The ecosystem is described and accessible to all stakeholders." (E1)</p> <p>"We need ecosystem communication and collaboration." (E2)</p>	<p>Clear, verbally expressed agreement</p>	<p>A31</p> <p>A41</p> <p>A51</p> <p>A61</p>
<p>Stakeholder map and possible quantification (for example, using Miral and assigning stakeholder groups)</p>	<p>x</p>	<p>x</p>	<p>What specific approaches are there for quantifying and evaluating the stakeholder map?</p>	<p>"The statement was formulated as a concrete clause by E1 and recorded as such with the agreement of the others."</p> <p>"The statement was formulated as a concrete clause by E1 and recorded with the agreement of the others."</p>	<p>Clear, verbally expressed agreement</p>	<p>A62</p>		
<p>2. Easier to implement than other sub-components and aspects, but not automatically present.</p>	<p>x</p>	<p>x</p>	<p>There is no quote text in German to translate. Can you provide the text you would like translated?</p>	<p>"The ecosystem is described and accessible to all stakeholders."</p>	<p>Clear, verbally expressed agreement</p>	<p>A31</p>		
<p>No text was provided to be translated.</p>	<p>x</p>	<p>x</p>	<p>There is no quote text in German to translate. Can you provide the text you would like translated?</p>	<p>"The ecosystem is described and accessible to all stakeholders."</p>	<p>Clear, verbally expressed agreement</p>	<p>A41</p>		
<p>The ecosystem is described and accessible to all stakeholders.</p>	<p>x</p>	<p>x</p>	<p>There is no quote text in German to translate. Can you provide the text you would like translated?</p>	<p>"The ecosystem is described and accessible to all stakeholders."</p>	<p>Clear, verbally expressed agreement</p>	<p>A51</p>		
<p>A common understanding was established among the stakeholders.</p>	<p>x</p>	<p>x</p>	<p>A common understanding was established among the stakeholders.</p>	<p>"The ecosystem is described and accessible to all stakeholders."</p>	<p>Clear, verbally expressed agreement</p>	<p>A61</p>		

Appendix 4: Comparison of suggested CE action area content from the SLR and focus group

Topic input	SLR	Focus group
<b>1. Internal Company Management</b>		
- Change Management	x	(x)
- Leadership	x	(x)
- Financial Management	x	0
- Risk Management	x	(x)
<b>2. Circular Strategy</b>		
- Organizational Strategy	(x)	x
- IT Strategy	x	x
<b>3. IT &amp; Digitalization</b>		
- Digitalization and Infrastructure Standards	x	x
- Adoption of New Technologies	x	x
- Data Management	x	x
<b>4. Ecosystem</b>		
- Collaboration	x	(x)
- Communication	(x)	x
<b>5. External Influences</b>		
- Market based	x	x
- Formal	x	x

Appendix 5: Evaluation assessment of the CE Maturity Model

Assessment statements (Ecosystem):	Does not apply at all (0P)	Does not apply (1P)	Applies rather not (2P)	Rather applies (3P)	Applies (4P)	Applies completely (5P)
The shared understanding of the ecosystem is accessible to all stakeholders.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
There is excellent, regular communication for promoting CE in the ecosystem.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The cooperation and collaboration towards common CE goals between stakeholders is optimally established and leads to circular solutions.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Stakeholder management is carried out at a very high level in order to actively involve the stakeholders.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

<b>Assessment statements (External Influences):</b>	<b>Does not apply at all</b> <i>(0P)</i>	<b>Does not apply</b> <i>(1P)</i>	<b>Applies rather not</b> <i>(2P)</i>	<b>Rather applies</b> <i>(3P)</i>	<b>Applies</b> <i>(4P)</i>	<b>Applies completely</b> <i>(5P)</i>
Customers are strongly convinced by the circular movements of the company through functionality, emotionality, and monetary incentives.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The current market situation has been analyzed in detail for CE implementation.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The legal requirements for the implementation of CE are fully met.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Promotion programs for circularity are proactively identified and perceived in relation.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Competitors are clearly surpassed in terms of CE.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
A quantified and verified reporting on all indicators is available for all stakeholders.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Legal requirements and guidelines for CE implementation are proactively met and exceeded.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The company is very well positioned in the market and successfully meets the demand for circular solutions.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

<b>Assessment statements (Company Management):</b>	<b>Does not apply at all</b> <i>(0P)</i>	<b>Does not apply</b> <i>(1P)</i>	<b>Applies rather not</b> <i>(2P)</i>	<b>Rather applies</b> <i>(3P)</i>	<b>Applies</b> <i>(4P)</i>	<b>Applies completely</b> <i>(5P)</i>
Systematic change management practices are applied to support CE transformation processes.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The leadership culture of the company exemplifies circularity and drives circular topics.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Organizational adjustments are comprehensive for the CE and employees are responding positively to them.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The financial management is ideally aligned with CE and economic CE benefits are perceived.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The risk management is focused on CE and a resilience towards operational risks is built.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The corporate culture of the company promotes circular culture in an outstanding way.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

<b>Assessment statements (IT &amp; Digitalization):</b>	<b>Does not apply at all</b> <i>(0P)</i>	<b>Does not apply</b> <i>(1P)</i>	<b>Applies rather not</b> <i>(2P)</i>	<b>Rather applies</b> <i>(3P)</i>	<b>Applies</b> <i>(4P)</i>	<b>Applies completely</b> <i>(5P)</i>
The gold standard of circularity is verifiably adhered to throughout the infrastructure.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Only IT that is compatible with current, sustainable standards is used.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The IT processes and IT sourcing services run in a circular manner.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The use of new technologies such as AI, IoT, and cloud for consumer electronics is exemplary and revolutionary.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The strategic concept of the field of action IT and digitization is specifically and measurably formulated.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The action-oriented strategic concept is agile and adapts quickly to changing requirements of the CE.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
CE-relevant data is collected and stored to an appropriate extent.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The introduction of new technologies and IT infrastructure only happens if necessary and as an applied principle.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The data strategy is fully focused on supporting CE and optimizing overall performance.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The data management is highly efficient and enables optimal utilization of resources and information for CE.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The IT infrastructure provides the necessary scalability for circular, multi-layered processes.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The data management for CE is transparent and allows for comprehensive analysis and evaluation.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

<b>Assessment statements (Circular Strategy):</b>	<b>Does not apply at all</b> <i>(0P)</i>	<b>Does not apply</b> <i>(1P)</i>	<b>Applies rather not</b> <i>(2P)</i>	<b>Rather applies</b> <i>(3P)</i>	<b>Applies</b> <i>(4P)</i>	<b>Applies completely</b> <i>(5P)</i>
The strategy is in line with a number of ecological, economic, and social corporate goals.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The strategy includes action-based and measurable strategic objectives.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The company provides exemplary transparency and comprehensibility of the strategy towards stakeholders.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Regular, purposeful business-IT alignment takes place.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The strategy concept is regularly checked for compliance with CE and, if necessary, revised as quickly as possible.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Before implementing strategy changes, a careful analysis of the impact on the CE implementation takes place.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The strategy includes a development plan regarding the other areas of action (ecosystem, external influences, corporate management, IT & digitalization).	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The strategy supports CGMI and enables a seamless CGMI alignment.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The strategic alignment consists entirely of circular processes with CE single strategy application.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The strategic orientation consists in parts of circular processes with CE framework application.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



## **Relationships of Internet use, victimization and violations of regulations with Cyber Gender-based Violence and Gender-based Violence**

Daniela Šincek<sup>1</sup>, Silviya Miteva<sup>2</sup> and Ivana Marčinko<sup>1</sup>

<sup>1</sup>Faculty of Humanities and Social Sciences Osijek, Croatia

<sup>2</sup>The South-West University "Neofit Rilski" Blagoevgrad, Bulgaria

### **Abstract**

Gender-based violence (GBV) especially affects women and gender minorities. With the development of digital technologies, cyber gender-based violence has (CGBV) also emerged. Different ecological models of GBV recognize the importance of victimization and violations at the individual level. Therefore, this research examined the relationship among the Internet use, victimization, and the commission of offenses with CGBV and GBV. 250 students from two universities (University of Osijek and The South-West University "Neofit Rilski") participated in the study, 129 of which were from Osijek and 211 were women (84.4%), with an average age of 22.95 years ( $SD = 3.72$ ). Students evaluated their Internet use and assessed the level of victimization and involvement in regulation violations. They completed the CGBV (18 items per subscale) and GBV scales (16 items per subscale), each with two subscales related to committing and experiencing violence. Four multiple regressions were conducted, where the criteria were experiencing/committing CGBV, and experiencing/committing GBV respectively. The model explains 13.9% of the variance in experiencing CGBV, 13.1% in committing CGBV, along with 10.2% in experiencing GBV, and 5.5% in committing GBV. While Internet use was an insignificant predictor for all four criteria, victimization and violation of regulations were significant predictors of committing and experiencing CGBV, victimization is predictive of experiencing GBV, and violation of regulations is a predictor of committing GBV. All significant beta coefficients are positive, that is, participants who have experienced a higher level of victimization and who violate more regulations are more involved in CGBV and GBV.

*Keywords:* cyber gender-based violence, gender-based violence, victimization, violation of regulation, university students

## **Introduction**

Gender-based violence (GBV) is a problem that has existed for a long time, but the general and professional public is becoming more and more aware of the adverse consequences of this violence. The Covid-19 pandemic has significantly increased the frequency of GBV (Mittal & Singh, 2020; Murhula et al., 2021), especially related to domestic violence, as people spent more time in their homes due to quarantine and movement restrictions, and help was less available to victims (Sapire et al., 2022). At the same time, people's focus on digital technologies has been increasing over the last decades, and a large increase in the use of digital technologies was again present during the Covid-19 pandemic, and was especially pronounced in education (Vargo et al., 2021).

Greater focus on digital technologies also means greater exposure to the risks that these circumstances can bring. One such risk is cyber gender-based violence (CGBV). Mishna et al. (2023) conducted a series of focus groups with adolescent girls in Canada which revealed some of the consequences of lockdown and COVID-19. They concluded that the lack of physical contact increased the pressure to sext, and that adults shifted their attitudes about digital technology from seeing it as a source of risk to it being a necessity, and encouraged children to spend time online studying during lockdown. Nevertheless, lockdown allowed parents more time to talk with their children, so they could discuss about sexting. However, there is still a need for expert support for both children and parents in dealing with nonconsensual sexting. Research (Soto et al., 2023) conducted in Chile on a convenient sample showed that as many as 73.8% of participants experienced CGBV and that the most commonly reported forms of digital violence included verbal violence, harassment, sending sexual images without consent, defamation, threats, and loss of account or non-consensual access. However, it should be kept in mind that the research was conducted by an NGO dealing with GBV, as well as being conducted during the COVID-19 pandemic, which are the probable reasons it resulted in such a high prevalence. In a meta-analysis (Patel & Roesch, 2020), it was shown that the prevalence is much lower than that found in Chile, and is mostly below 10% for both committing and experiencing different forms of CGBV.

The definition of gender-based violence is often focused on violence against women (VAW), as in the following definition: "Any act of gender-based violence that results in, physical, sexual or psychological harm or suffering to women, including threats of such acts, coercion or arbitrary deprivations of liberty, whether occurring in public or in private life" (Degener & Koster-Dreese, 1995, p. 2) and some authors use VAW and GBV interchangeably indicating that GBV is most often directed at women. However today, GBV is more often

defined as: "an umbrella term for any harmful act that is perpetrated against a person's will, and that is based on socially ascribed (gender) differences between males and females" (Inter-Agency Standing Committee, 2005, p. 7). When this violence takes place on the Internet, via digital technologies, or social networks, terms such as online gender-based violence (Suzor et al., 2019), digital gender-based violence (Soto et al., 2023), technology-facilitated sexual violence (Patel & Roesch, 2020), or cyber gender-based violence (Armiwulan, 2021) are used.

The integrated ecological model proposed by Heise (1998), adapting Bronfenbrenner's Ecological models of human development (Bronfenbrenner, 1994), is often used to explain GBV. In this model, the interconnectedness of individual, relationship, community, and societal factors contributes to involvement in GBV. At the individual level, personal characteristics (e.g. age, education, income), attitudes, and beliefs about gender roles, violence, and history of victimization or perpetration are important, while at the relationship level, dynamics of power and control within relationships, communication patterns, and conflict are important. The community level includes social norms regarding gender and violence, availability of support services for victims, and economic and social inequalities, and for the societal level, cultural beliefs and practices related to gender and violence, legal and policy frameworks, and media representations of gender and violence are important (Heise, 1998). In a systematic review of GBV predictors, Rubenstein (2020) emphasizes the key predictor is conflict exposure. In this paper, the emphasis will therefore be on the factors from the individual level, specifically the history of victimization and the violation of regulation. In addition to these variables, the authors emphasize the time spent on the Internet (Kavanagh & Brown, 2020) as a risk factor for CGBV.

Mtotywa et al. (2023) stress that childhood experiences of violence, trauma, substance abuse, stress, and depression contribute to normalizing violence in later life. Victims of GBV often experience physical harm, mental health issues, and socioeconomic challenges, leading to stigmatization, rejection, and decreased earnings. This is why it is important to systematically study what contributes to GBV, as well as CGBV, in order to be able to develop informed prevention programs. Therefore, in this paper, we investigate how the use of the Internet, victimization during childhood (including witnessing violence between parents, experiencing both peer violence and different types of violent and abusive behavior by adults) and misdemeanor and criminal offenses contribute to the explanation of the variance of GBV and CGBV. The following hypotheses were proposed:

H1: Victimization in childhood and the experience of breaking the law and the use of Internet are positively related to committing and experiencing both GBV and CGBV.

H2: Victimization will be a more significant predictor for experiencing these types of violence, while breaking the law will be a more significant predictor for committing GBV and CGBV.

H3: Internet use will be more significantly associated with CGBV than with GBV.

## Methodology

### *Participants*

The study involved 250 students from two universities (University of Osijek; N=129, and The South-West University "Neofit Rilski"; N=121). Out of the total number of participants, 211 declared themselves as women (84.4%), 37 as men, and one person as non-binary, while one person chose not to declare gender. The average age of the participants was 22.95 years (SD=3.72, ranging from 18 to 30 years of age). The sampling method used was convenience sampling.

### *Measures*

**The sociodemographic questionnaire** consists of 12 items that examine the age of the participants, the university they attend, year of study, place of residence, gender, gender identity, sexual orientation, romantic status, frequency of Internet use (compared to an average young person, on the scale from 1 to 9, 1 being extremely below the usage of an average young person, 5 indicating using internet equally as long as an average student, and 9 being extremely above the usage of an average young person) and exposure to violence during their lifetime, whether it was experienced or witnessed by the participants (six items, answers were given on a 5-point scale from never to always, the total result was the average of the participant's answers) and committing misdemeanors and criminal acts (two items, again, answers were given on a 5-point scale from never to always, total result was the average of the participant's answers).

**The scale of gender-based violence on the Internet (RUN-I, Šincek et al., 2024)** was created for the purposes of the project this research is part of. It consists of two subscales: the subscale of committing and the subscale of experiencing gender-based violence on the Internet. Each of the mentioned subscales contains 18 items to which the participants answer on a scale from 1 to 5 (1 = never, 2 = rarely, 3 = sometimes, 4 = often, 5 = very often), considering how often they exhibited or experienced a certain behavior in the last year. The result was separately calculated for each subscale.

*The scale of gender-based violence (RUN, Šincek et al., 2024)* was also created for the purposes of this research, based on similar scales used to measure this type of violence in the student population. It consists of two subscales - the subscale of committing and the subscale of experiencing gender-based violence in-person. Each of the mentioned subscales consists of 16 items that describe the behaviors the participants experienced or committed, which are classified as in-person gender-based violence in the past year. The result is formed as a simple linear combination of answers on a particular subscale.

### *Procedures*

This study is a part of two larger projects named "Prevention and Support for Cyber Gender-Based Violence" (PS-CGBV) funded by the Erasmus+ Programme, KA220-YOU - Cooperation partnerships in youth, and "Cyber gender-based violence at the University of Osijek" (UNI-CGBV) Center for Internet and Society, Faculty of Humanities and Social Sciences. The PS-CGBV project lasted for 24 months, and part of the last project task is the implementation of qualitative and quantitative research, which will determine the characteristics of CGBV. The UNI-CGBV lasts 12 months, and this is the initial part of the research, which aims to establish the prevalence and correlates of GBV and CGBV at the University of Osijek. In this part, according to the principle of availability, the students of the two universities were given questionnaires on a Google forms link in Croatian and Bulgarian. The Croatian original was first translated into English, then into Bulgarian. Voluntary and anonymous participation was explained to the participants, and the research was approved by the Ethics Committee of the Faculty of Humanities and Social Sciences.

### **Results**

A series of four multiple regression analyses were conducted to explore the goal of the study. In each regression, the same predictors were included: Internet use, victimization, and the committing of offenses. The criteria were experiencing and committing CGBV, and experiencing and committing GBV, respectively.

Table 1 contains descriptive statistics for relevant variables. As expected, Table 1 shows that violent behaviours are rare, both experiencing childhood victimization and committing and experiencing CGBV and GBV. Misdemeanours and criminal offenses committed by participants are also rare, while participants estimate that they use the Internet to the same extent as their peers.

**Table 1** Descriptive statistics for main variables (N=249)

	M	SD
Internet use	5.47	2,280
Victimization	1.53	0.636
Offenses	1.19	0.414
Experiencing CGBV	1.07	0.218
Committing CGBV	1.04	0.222
Experiencing GBV	1.14	0.284
Committing GBV	1.06	0.180

**Table 2** Correlation among main variables (N=249)

	1	2	3	4	5	6	7
1. Internet use	-	,095	-,002	,016	-,088	,068	-,036
2. Victimization		-	,259**	,295**	,195**	,312**	,110
3. Offenses			-	,297**	,329**	,135*	,225**
4. Experiencing CGBV				-	,837**	,629**	,585**
5. Committing CGBV					-	,373**	,619**
6. Experiencing GBV						-	,448**
7. Committing GBV							-

\*p<.05; \*\*p<.01

From Table 2, it is visible that Internet use is not related to the monitored criteria or other predictors, and that victimization is not related to committing GBV. The other variables are all positively correlated at a risk level of 1%, except for the positive correlation of misdemeanour and criminal offenses with experiencing GBV, which is significant at a risk level of 5%. Despite the lack of connection, to check the proposed hypotheses of the research, variables that were not significantly correlated with the criterion were included in the multiple regressions.

Table 3 shows the results of multiple regressions. It can be seen that the model explains 5.5% of the variance of committing GBV, 10.2% of the variance of the experiencing GBV, 13.9% of the variance of the experiencing CGBV, and 13.1% of the variance of the committing CGBV. The use of the Internet, as expected given the insignificant correlations, did not prove to be a significant predictor of any of the predictors. For CGBV, victimization and committing misdemeanours and criminal acts are predictors of both committing and experiencing, while for GBV, childhood victimization is predictive of experiencing, and committing criminal and misdemeanour acts are predictive of committing GBV.

**Table 3** Results of the four multiple regressions

Criteria	Variables	B	SE	$\beta$	t	R <sup>2</sup>	F
Experiencing CGBV	Internet use	-.001	.006	-.006	-.092	.139	13.22**
	Victimization	.081	.021	<b>.235</b>	3.80**		
	Offenses	.124	.032	<b>.236</b>	3.85**		
Committing CGBV	Internet use	-.010	.006	-.098	-1.635	.131	12.35**
	Victimization	.045	.022	<b>.128</b>	2.06*		
	Offenses	.159	.033	<b>.297</b>	4.81**		
Experiencing GBV	Internet use	.005	.008	.041	.676	.102	9.30**
	Victimization	.131	.028	<b>.293</b>	4.651		
	Offenses	.041	.043	.059	.945		
Committing GBV	Internet use	-.003	.005	-.041	-.656	.055	4.77**
	Victimization	.017	.018	.060	.931		
	Offenses	.091	.028	<b>.209</b>	3.251		

\*p&lt;.05; \*\*p&lt;.01

## Discussion

In this paper, we wanted to explore how the use of Internet, victimization during childhood and committing offenses and criminal offenses contribute to the explanation of the variance of committing and experiencing both GBV and CGBV.

For this purpose, four multiple regressions were performed, which showed that these four predictors explain less than 15% of the variance of the criteria. Although it turned out that there is a good fit of the model, their explanatory power is not great and there are obviously many other factors that contribute to these phenomena. Such factors may also include individual level factors such as attitudes and beliefs about gender roles (Heise, 1998). It is likely that age and education are also important, as Heise (1998) predicts, but as the participants were uniform in terms of education and age, these contributions were not tracked.

Surprisingly, Internet use was not found to be significant for CGBV, while it was not so surprising for GBV. Namely, research shows that, for example, children and young people who spend more time online are more likely to experience cyberbullying (Chi et al., 2020), adults who spend more time on the Internet have more positive attitudes towards cyberbullying (Barlett et al., 2019), while Mishra (2021) indicates that women who spent more time on the Internet had a greater likelihood of experiencing CGBV. However, it should be noted that, in contrast to previous research, the time spent online by participants was not based on an absolute estimate of time, in the number of hours, but rather based on their social comparison, i.e. an estimate of how much time they spend online comparing themselves to average young people

(on a scale from 1 to 9, where 1 means significantly less time, five is an equal amount of time, and 9 is much more than the average). Such self-assessment probably led to the participants comparing themselves with other young people with whom they normally socialize and are alike to them. However, it is evident that the standard deviation is satisfactory. The reasons for this way of measuring is a) that, after the COVID-19 pandemic, the number of tasks that students do online has increased, and b) the naturally occurring differences between students (for example, computer science students are expected to spend more hours online).

Victimization and violation of the law were found to be significant for both committing and experiencing CGBV. While both predictors have equal beta coefficients for experiencing CGBV, breaking the law contributed more significantly to committing CGBV than victimization. According to the latter, breaking the law is the only significant predictor for committing GBV, while victimization is the only significant predictor for experiencing GBV. In earlier studies, it was shown that victims of GBV are more exposed to victimization, and perpetrators are more likely to violate various norms and regulations (Mtotywa et al., 2023). The different ways in which the same predictors function in CGBV and GBV indicate that, in addition to numerous links, there are also specificities of these two types of violence that should be taken into account.

Although in our opinion the knowledge gained from this research can contribute to the understanding of the phenomena of gender-based violence, which, especially in recent times, is proving to be a great challenge for the well-being, especially of young people in higher education, despite the relative rarity of these behaviors, this research also has its shortcomings. The measures of both predictors and criteria, although they were developed based on theoretical knowledge, were, due to the lack of already developed and proven measures, developed for the purpose of this research and the projects within which the research takes place. This implies that it will be necessary to further assess the appropriateness of these measures. As explained earlier, due to the specific sample (student population), we decided to use the measurement of Internet use, while it would be useful to monitor the amount of time, content, as well as problematic Internet use.

In addition to shortcomings, our research also has contributions - it points to the specifics of the contribution of victimization and violation of the law in these two types of violence due to one's gender identity or sexual orientation. An important contribution is conducting research in two countries, where it is necessary to emphasize the uniformity of the experiences of students in those two countries, i.e. the young people are completely comparable.



Namely, the cultural context is also important within the framework of ecological theory, especially for gender-based violence, and in this way, our research contributes to these findings.

## **Conclusion**

This research found that greater victimization in childhood and more violations of regulations predict both committing and experiencing CGBV, while in GBV, victimization is a positive predictor of experiencing, and violation of the law is a positive predictor of committing GBV. This research on student sub-samples from two countries indicates that the relationships of these variables are similar in both cultures and emphasizes the importance of early prevention of victimization and risky behaviour of children and young people leading to regulation of violations, which could prevent the later involvement in violence based on someone's gender, sexual orientation or sexuality.

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## **Relationship Among School Climate, Depression, Anxiety, Stress And Compulsive Social Media Use**

Gabrijela Vrdoljak<sup>1</sup>, Toni Maglica<sup>2</sup> and Darko Roviš<sup>3,4</sup>

<sup>1</sup>Faculty of Humanities and Social Sciences, University of Osijek, Croatia

<sup>2</sup>Faculty of Humanities and Social Sciences, University of Split, Croatia

<sup>3</sup>Teaching Institute of Public Health of the Primorsko-goranska County, Croatia

<sup>4</sup>Faculty of Medicine, University of Rijeka, Croatia

### **Abstract**

Today's youth are also called “digital natives” because they have not experienced life without the Internet. The rise of social networks has revolutionized communication methods and led to increased screen time among the youth. Despite its many benefits, excessive use of social networks can have negative effects on daily routines, school performance and mental health. While evidence suggest that positive school climate is associated with fewer risky behaviours and less mental health problems in real life, there is a growing interest in understanding whether these benefits also apply to behaviours and outcomes within the digital realm. The aim of this study was to examine the relationship among school climate, depression, anxiety and stress and compulsive social media use in high school students. A cohort of 3621 second-year high school students participated in the study, of which 46% were male, 51% were female, and 3% did not want to declare their gender. The following questionnaires were used in the research: Croatian school climate questionnaire, DAS (depression, anxiety, and stress) scale and Compulsive social media use scale. The results showed that school climate is a significant negative predictor of compulsive social media use, and that depression and stress are significant positive predictors of compulsive social media use. Also, a significant mediating role of depression and stress in the relationship between school climate and compulsive social media use was obtained. Thus, a positive school climate is related to fewer symptoms of depression and stress, which is related to less compulsive social media use.

*Keywords:* school climate, depression, anxiety, stress, compulsive social media use

### **Introduction**

Young people are devoting a growing portion of their time to online pursuits and maintaining connections through digital means. Ownership of mobile devices and engagement with social media have reached unprecedented levels among adolescents. The wide use of social networking has transformed communication landscapes. Today's youth, often referred to as "digital natives" (Prensky, 2001) are individuals who have never experienced life without the Internet and have different ways of interacting with technology and processing information. Among adolescents, social media has become extremely popular in the past decade, but it should be kept in mind that it is difficult to clearly analyse the effects of social media and digital technology from the noisy background of adolescent life (Orben et al., 2020).

Digital technology has undoubtedly brought numerous benefits, including quick access to information and new ways of social interaction. In addition, research has shown that active uses of social media in direct communication, like messaging or posting on another social media profile increase their wellbeing and help maintain personal relationships (Burke et al., 2010; Ellison et al., 2014). However, concerns have been raised about the potential negative impacts of excessive screen time and social media use, especially passive use such as scrolling through social media and news feeds. These behaviours are not associated with positive outcomes (Burke & Kraut, 2016). The negative outcomes include disruptions to daily routines, poor academic performance and adverse effects on mental health (Twenge & Campbell, 2018). Preoccupation with social media impairs other social activities, school/work, interpersonal relationships and psychological health and well-being (Schou Andreassen & Pallesen, 2014). There is an abundance of evidence that internet addiction is related with depression and anxiety symptoms as well as to other psychiatric conditions (Xie et al., 2023). Likewise, the utilization of social media has been correlated with heightened levels of depression, anxiety, and stress, as well as symptoms indicative of other psychiatric disorders (Hussain & Griffiths, 2018).

The objective of this study is to investigate several of the aforementioned constructs and their interrelations, particularly within the framework of the school environment. Given its significance alongside the family, the school environment emerges as one of the most crucial contexts for adolescents. It is widely acknowledged that a nurturing and supportive school environment can serve as a secure place for adolescents. This can be understood and explained through theories like Social Control Theory (Hirschi, 1969) and the Social Development Model (Catalano & Hawkins, 1996). These theories suggest that strong emotional bonds, personal commitment, and active participation in the school community can protect students from engaging in risky behaviours. Thapa et al. (2013) argues that schools that promote an atmosphere of trust and cooperation and support create a safer and more inclusive environment

for students, that has an impact on their academic performance, psychological adjustment, reduced engagement in risky behaviours, and fewer mental health issues. SDM model further emphasizes that supportive relationships with teachers and peers, coupled with an alignment with the school's rules, norms and values, contribute to a school bonding that influences a student's psychological well-being. A positive school climate that fosters real-world relationships, and encourages active participation, helps build the resilience needed to face the challenges of adolescence. Caring and positive relationships at school have been shown to be crucial in encouraging positive adolescent adjustment and preventing negative outcomes (Cohen & Freiberg, 2013).

This includes navigating the complexities of adolescence in a digital age and mitigating the adverse effects associated with stress, depression, anxiety, and problematic internet use. Current research indicates that a positive school climate is associated with numerous benefits influencing mental health, there is a need to better understand how these benefits translate into the digital domain, particularly in the context of social media usage patterns. Zhai et al. (2020) found that perceived school climate is negatively associated with problematic internet use and depressive symptoms mediates this association. It seems that adolescents who have problems in establishing supportive emotional connection to their teachers and peers may experience more emotional problems and turn to excessive Internet and social media use to cope with these emotions (Zhai et al, 2020). Also, the students having difficulties with coping with school stress that increases their anxiety and probability of them developing an addiction to the Internet (Shen et al, 2023).

With regard to the theory presented earlier, the focus of this research is to examine whether compulsive social media use can be predicted based on the school climate and symptoms of depression, anxiety and stress in high school students. Specifically, the objective is to analyse whether the school climate has an indirect effect on compulsive social media use through symptoms of depression, anxiety, and stress.

## **Methods**

### **Participants and procedure**

The research was part of the broader project: Testing the 5C framework of positive youth development: traditional and digital mobile assessment - P.R.O.T.E.C.T. funded by Croatian Science Foundation (UIP-2020-02-2852). A cohort of 3621 second-year high school students participated in the study during early 2023, of which 46% were male, 51% were

female, and 3% did not want to declare their gender ( $M = 16.40$ ,  $SD = 1.65$ ). Students attended schools in eight cities in Croatia, 34.8% attended grammar schools, 50.7% four- or five-year vocational schools and 14.5% three-year vocational schools.

The survey lasted about 40 minutes and was conducted online during regular classes using the SurveyMonkey platform. Participation was voluntary, and consent was given by the adolescents and their parents. The approval for the study was obtained from the institutional ethics committee, Ministry of Science and Education and National Agency for Education.

## Measurements

*Croatian school climate questionnaire* (Velki et al., 2014) contains 15 items. The questionnaire is characterized by one-factor structure and contains items that include a sense of belonging and safety at school, relationship between teachers and students, atmosphere for learning, and parental connection with school and involvement in children's education. Participants respond to the items on Likert-type scale from 1 = strongly disagree to 5 = strongly agree. The result is formed as the sum of the results on individual items, and a higher result indicates a more positive school climate. The reliability of this scale is  $\alpha = .93$ .

*Depression, Anxiety and Stress Scale* (DASS-21) (Lovibond & Lovibond, 1995) contains 21 items divided into three subscales: depression, anxiety and stress (seven items each). Participants respond to the items by rating how well they describe their feelings over the past week choosing a number on a Likert-type scale from 0 to 3, where 0 = did not apply to me at all and 3 = applied to me quite a lot or almost always. Within each subscale, the total score was formed by summing the responses. The reliability of the depression scale is  $\alpha = .91$ , the anxiety scale  $\alpha = .89$  and the stress scale  $\alpha = .91$ .

*Compulsive social media use scale* (Jovičić Burić et al., 2021) represents an adapted version of the Compulsive Internet Use Scale (CIUS; Meerkerk et al., 2009) and contains 14 items. Participants respond to the items on Likert-type scale from 1 = strongly disagree to 5 = strongly agree. The result is formed as the sum of the results on individual items, and a higher result indicates a more compulsive media use. The reliability of this scale is  $\alpha = .91$ .

## Results

In order to address the research problems, descriptive statistics, correlations between the used variables and regression analysis were conducted. A detailed presentation of the obtained results follows.

**Table 1.** Descriptive statistics, skewness, and kurtosis of all measured variables

Variable	<i>M</i>	<i>SD</i>	Skew	Kurt
School climate	47.48	11.63	-.42	.34
Depression	5.85	5.38	.87	-.03
Anxiety	5.57	5.17	.97	.23
Stress	6.64	5.42	.64	-.42
Compulsive social media use	37.79	10.99	.17	-.10

The central values of depression, anxiety and stress were in the lower parts of the range (possible range from 0 to 21), which is expected considering that it is a non-clinical population. The mean of compulsive social media use in this sample, was somewhat higher (the arithmetic mean is around the middle of the range) than in earlier research. In the research Jovičić Burić et al. (2021) the average score on the Scale was 32.10.

Students assess the school climate as mostly positive, given that the arithmetic mean was in the higher part of the range (possible range from 15 to 75). The authors of the questionnaire (Velki et al., 2014) reported average values from 30.79 to 36.60.

The results also showed that variables have a normal distribution trend considering that the skewness is in the +/-3 and the kurtosis is in the +/-10 range (Kline, 1998).

**Table 2.** Correlation Matrix of the study variables

Variables	1.	2.	3.	4.	5.	6.
1. School climate	-	-.26**	-.20**	-.20**	-.14**	-.02
2. Depression		-	.78**	.82**	.34**	.26**
3. Anxiety			-	.84**	.32**	.34**
4. Stress				.	.36**	.34**
5. Compulsive social media use					.	.22**
6. Gender						-

Legend: \*  $p < .05$ . \*\*  $p < .01$ .



In the correlation table (Table 2), it can be seen that the compulsive social media use was negatively related to the school climate, and positively related to anxiety, depression and stress. The gender was added to the correlation matrix, girls reported higher values on the compulsive social media use scale.

**Table 3.** Results of hierarchical regression analysis for criteria compulsive social media use

Model	R <sup>2</sup>	F	β
1. step	.05	149.58**	
Gender			.22**
2. step	.07	111.61**	
Gender			.22**
School climate			-.14**
3. step	.15	110.48**	
Gender			.12**
School climate			-.07**
Depression			.10**
Anxiety			-.02
Stress			.24**

\*\*p < .01

Regression analysis showed that all predictors together explained 15% of compulsive social media use.

In the first step, gender was included as a control variable, given that some earlier research indicates gender differences in compulsive social media use (Tsitsika et al., 2014, Su et al. 2020). The results showed that gender is a significant predictor, and the findings indicate that girls exhibited higher values on the compulsive social media scale.

In the second step, the school climate was added, which proved to be a significant negative predictor of compulsive social media use.

In the third step, depression, anxiety and stress were introduced. Both, depression and stress proved to be significant positive predictors of compulsive social media use. Additionally, it is evident that with the introduction of depression and stress variables, the significance of the school climate decreased from -.14 to -.07 in the third step. Consequently, a mediation analysis will be carried out to further investigate this relationship.

Mediation was verified by the Hayes process (Hayes, 2013). The analysis revealed significant direct and indirect effects. Notably, school climate exhibited a significant direct effect on compulsive media use (effect =  $-.06$ ,  $t = -3.39$ ,  $p = .00$ , CI 95% =  $-.09$  to  $-.02$ ). Depression (effect =  $-.02$ , CI 95% =  $-.04$  to  $-.01$ ) and stress (effect =  $-.05$ , CI 95% =  $-.07$  to  $-.04$ ) emerged as significant partial mediators in the relationship between school climate and compulsive media use. Consequently, it is evident that school climate influences compulsive media use both directly and indirectly through the mediating factors of depression and stress.

### **Discussion and conclusion**

Having in mind the aim of this study, which was examining the relationship between school climate, depression, anxiety and stress and compulsive social media use in high school students, the results are quite expected and in line with other similar research. The way how social media influences adolescents' well-being has become a priority due to the constant increase in their mental health problems (Kim, 2017).

One of our initial findings from this research suggests that depression and stress serve as significant positive predictors of compulsive social media use. This result from Croatian sample aligns with numerous meta-analysis and systematic reviews that have demonstrated significant relationships between social media and depressive symptoms among children and adolescents (Keles et al., 2020; Hoare et al., 2016; Marino et al., 2018, Odgers & Jensen, 2020). Conversations regarding the adverse impacts of smartphones and social media are occurring concurrently with rising apprehensions about adolescents' mental well-being. Constant increase in depression, anxiety, and suicide rates, particularly among girls, who are the most frequent users of new media, have prompted suggestions that smartphones and social media might be contributing to the escalation of suicidal tendencies, depression, and feelings of isolation (Rosenstein & Sheehan, 2018; Mojtabai et al., 2016). But, there are still a lot of inconsistencies in this field of research. For example, Jensen et al. (2019) conducted an ecological momentary assessment (EMA), tracking adolescents on their smartphones to test whether more time spent using digital technology has an association with worse mental health outcomes. Their results demonstrated that technology usage does not predict mental health symptoms, on the contrary, teens reported sending more text messages over the study period reported less depression and feeling better. These findings are in line with their previous research where adolescents deemed at risk for substance use and externalizing problems while spending more time online and texting, but a greater number of texts sent were associated with less same day anxiety, and more texts sent were also associated with less same day depression (Jensen et al, 2019).

Further on, the results from our research indicate that school climate negatively predicts compulsive social media use. Bozzato and Longobardi (2024) obtained similar results on the sample of Italian high school students where there was a negative correlation between school climate, connectedness to school, affective school engagement, and problematic smartphone and social media use. As it was described in the Introduction, a positive and nurturing school climate is associated with various positive outcomes related to students' mental health and wellbeing. Creating a supportive school climate for students in educational settings proves to reduce students' tendency to use social media networks (Emrullah & Hilal, 2022). At the same time, our results indicate that a positive school climate is related to fewer symptoms of depression and stress, which is then related to less compulsive social media use. School climate is undoubtedly important in developing a sense of belonging and bonding with teachers and peers. Adolescents who have problems establishing close and supportive relationships or might be experiencing academic pressure may feel under stress, anxious or depressive.

The mediating effect of depression and stress in the relationship between school climate and compulsive social media is in line with theory of compensatory internet use (Kardefelt-Winther, 2014) that suggests that individuals facing problems in real-life relationships may turn to online activities as a means to mitigate negative emotions. Zhai et al. (2020) found similar associations, where school climate was negatively correlated with problematic internet use, with both school belonging and depressive symptoms mediating the relationship. However, this relationship is not unidirectional; students may use social media excessively because they are looking for social interaction and approval, which may not happen, online communication may lead to the misleading impression of the physical and personality traits of other users. Others might be overusing social media because of fear of missing out, all of which again makes users more stressed, anxious or depressed (Chou & Edge, 2012; Andreassen et al.; 2016, Shensa et al., 2017; Atroszko et al. 2018).

In light of the aforementioned, an increasing consensus among scientists is emerging regarding how the consequences of social media use are dependent on individual differences (Odgers & Jensen, 2020). Some studies support the thesis that those who already have strong friendships might benefit from digital, online communication (Yau & Reich, 2017), while those with potential mental health issues might be more susceptible to the negative effects (Przybylski & Bowes, 2017).

## Limitations and implications

There are certain limitations of this study. One of the limitations is correlational design and self-assessment measures that are used. The sample includes only second-year high school students. Despite the existing limitations, a large number of adolescents (N = 3621) from different parts of Croatia were included in this research, so, based on the data, we can draw some important conclusions and recommendations. The obtained data indicate that the school climate is a negative predictor of compulsive media use and that adolescents who perceive the school climate as more positive have fewer symptoms of depression and stress, which then results in less compulsive social media use. This is important knowledge for teachers who can work on supportive and warm relationships at school, a safe and pleasant school environment and active participation of students in school activities. This should have a positive effect on mental health and less compulsive social media use.

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## **Analysing Teachers' Standpoint about ICT Role in Growth of Social And Citizenship Competences: A Neural Network Approach**

Ivana Đurđević Babić<sup>1</sup> and Natalija Bošnjaković<sup>2</sup>

<sup>1</sup>Faculty of Education, University of Osijek, Croatia

<sup>2</sup>Primary school Vođinci, Croatia

### **Abstract**

The Republic of Croatia has placed a greater emphasis on the development of personal, social and citizenship skills by adopting a curriculum-based approach to teaching. Social and citizenship competences include skills such as communication, conflict resolution, understanding of social mechanisms and many others that contribute to the improvement of the quality of life. Information and communication technologies (ICT) enable communication, can help individuals to participate in social activities and provide access to a wide range of information. Responsible use of ICTs is crucial to optimize the benefits for improving social and citizenship competences while being aware of the potential challenges and risks they can bring. Given the importance of effective social interaction and citizenship education in addressing the challenges of living in today's society, this paper focuses on discovering relationships between different variables and teachers' attitudes that ICT use plays a positive role in, developing social and citizenship competencies that empower students to actively engage in the community. In order to discover the hidden patterns between teachers' opinions about the role of ICT in this matter and other variables, the neural network approach was chosen. The best neural network model created had an overall classification accuracy of 77.77% and was able to correctly classify all teachers who believe that the use of ICT has a positive effect on the development of social and citizenship competencies.

*Keywords:* citizenship competence, ICT, neural networks, social competence, teacher



## **Introduction**

How education can and should support the pro-social growth of young people is one of the questions that is gaining increased attention (Ten Dam & Volman, 2007). The Croatian education system has recognized the importance of these issues and introduced several cross-curricular topics through curricular reform, including, among other topics, Personal and Social Development and Citizenship Education.

“Personal and social development is an interdisciplinary theme that promotes the holistic growth of children and young individuals with the aim of fostering a well-rounded, self-assured, imaginative, productive, proactive, content, and accountable individual capable of collaborating and making meaningful contributions to society” (Ministry of Science and Education, 2019). This is essential for meeting the educational goals, to advance professionally and for fostering personal growth to manage emotional, mental, spiritual, and physical capabilities with optimism. On a societal level, it promotes healthy social connections and prepares youth for their roles within families, workplaces and communities (Ministry of Science and Education, 2019).

“Citizenship education is an interdisciplinary theme whose purpose is to educate and empower students to perform a citizenship role actively and effectively. This implies responsible members of class, school, local, national, European and global communities” (Ministry of Science and Education, 2019). Citizenship education empowers students to navigate diverse societies confidently, to rely on their abilities and to independently address contemporary social issues. Through gaining citizenship competence—comprising knowledge, skills, and attitudes—students are prepared to actively engage in democratic communities (Ministry of Science and Education, 2019).

By simplifying information access, encouraging communication and teamwork, improving digital literacy, enabling citizenship involvement and raising awareness of global citizenship, information and communication technology (ICT) can be a powerful tool for boosting social and citizenship competency. While ICT offers numerous benefits for improving social and citizenship competences, it is essential to address the associated challenges to ensure equitable access, to promote critical engagement, and to safeguard individuals' privacy and security online. The responsible use of ICTs is essential to optimize the benefits for improving social and citizenship competences while being aware of the potential challenges and risks they can bring.

## **Literature review**

The Choi et al. (2018) study aimed to investigate factors affecting teachers' digital citizenship levels defined by their attitudes, skills, and behaviours regarding Internet usage. The examined variables included classroom teachers' backgrounds (such as age, gender, experience, subject taught), Internet usage patterns (information sources, main purposes, utilizing online social networks as a pedagogical tool), and psychological traits (Internet self-efficacy and anxiety). An analysis utilizing descriptive, correlational, and multiple regression analyses uncovered several important findings. Firstly, teachers showed lower degrees of Digital Citizenship sub-factors such as Internet Political Activism and Critical Perspective. Secondly, a significant relationship was observed between the Internet self-efficacy and Digital Citizenship. Lastly, three variables, namely years of labour experience, use of social networking sites for teaching, and Internet self-efficacy, had a significant impact on teachers' views of digital citizenship.

The objective Almerich et al. (2021) research was to examine how the utilization of ICT (both personal and academic) affects the hierarchical structure of ICT competencies in relation to high-level skills. The findings revealed that ICT competencies, particularly those related to pedagogy, significantly influenced high-level skills, specifically higher order thinking abilities and collaboration competencies. Notably, academic use of ICT at home had a direct impact on all subsets of ICT competencies as well as teamwork skills. Additionally, this study highlights the adverse association between the academic ICT usage in the classroom and the ICT competencies, higher order thinking capacities, and collaboration competences.

Teachers from Germany and Hong Kong participated in semi-structured interviews as a part of Vajen et al.'s comparative study in 2023 to discover more about their perspectives on teaching methods in digital societies and digital citizenship. The teachers recognized the beneficial impact of digitalization on the opportunity for involvement and the availability of information. They rarely discussed more general effects of digitalization on the idea of citizenship, although they did express concerns about possible manipulation and meddling by antidemocratic groups (Vajen et al., 2023).

The study conducted by Karakoyun and Lindberg (2020) examined the viewpoints of preservice teachers regarding twenty-first-century competencies. The researchers discovered that Turkish and Swedish preservice teachers linked these skills with technology, digital citizenship, communication, and information literacy in their everyday lives. In educational context, the Turkish participants primarily associated twenty-first-century skills with information literacy and technology, whereas the Swedish participants placed emphasis on

technology, remote learning, and communication. The importance of digital literacy for future careers and students was unanimously recognized. The Turkish participants emphasized the need of critical thinking and problem-solving, while the Swedish participants identified communication and information literacy as secondary abilities.

The Zwaans et al. (2006) paper explored strategies for improving social skills of secondary education students, focusing on two approaches: 'educating for adulthood' and 'educating for citizenship'. The study examines teachers' educational goals in the social area through a survey. The results indicated a unified focus on goals that are in line with the perspective of 'educating for adulthood', while giving less importance to goals related to citizenship. The pre-vocational instructors exhibit lower levels of confidence in attaining these objectives in comparison to the ordinary secondary teachers. It is recommended that the instructional strategies should be created to assist teachers in promoting students' social competency, with a specific emphasis on citizenship aspects.

The research conducted by Liesa-Orús et al. (2020) investigated the impact of Information and Communication Technologies on the development of the 21st-century skills in higher education. It emphasizes the importance of examining the perspectives of university teachers as a critical determinant of their use of these tools. A quantitative study was conducted with 345 professors from different disciplines in a Spanish university. The results of the study showed that professors recognize the capacity of ICTs to improve student learning and foster important abilities such as communication, collaboration, and critical thinking. Furthermore, they underscored the significance of instilling a culture of technology education. The study emphasizes the importance of incorporating ICTs into teaching methods and giving priority to training professors in digital abilities.

The assessment of teacher- or student-specific competencies, including digital, social, citizenship, emotional and other 21st century competencies, is the focus of most current studies. There is a lack of research that specifically examines teachers' perspectives towards the impact of ICT on the development of the 21st century students' skills. Therefore, this paper discusses teachers' general attitudes towards today's students and their learning habits in comparison to previous generations, teachers' attitudes toward their own teaching methods and the incorporation of digital technologies into their teaching, their views on the positive impact of ICT on various aspects of children's development and skill development, and their perspectives on educational goals and upbringing. Also, this paper aims to explore the connections between various variables and teachers' attitudes towards the use of ICT in developing social and citizen competencies. It recognizes the importance of the effective social interaction and citizenship

education in addressing the challenges of modern society and seeks to understand how ICT can positively contribute to empowering students to actively participate in their communities.

### **Methodology and results**

Due to its effectiveness in data collection, this study, which took place in 2023, used the social network Facebook and an online questionnaire in which 92 participants took part. The questionnaire consisted of 6 general demographic questions (gender, age, county where the teacher works, urban or rural area, job title and years of service) which were used to create a more detailed profile of the teachers who participated in the study. Four blocks of statements followed, in which the teachers had to indicate their agreement with these statements on a 5-point scale from "strongly disagree" (1) to "strongly agree" (5). The first block of statements (23 statements) related to teachers' general attitudes towards today's students and their learning habits compared to the previous generations of students. The next block (13 statements) was related to teachers' attitudes towards their teaching and the use of digital technologies in their lectures. The third block dealt with their attitudes about the positive impact of ICT on different components of children's development and the development of different competences (15 statements). The last block of statements (4 statements) dealt with their attitude towards the upbringing-educational goals.

The majority of participants in this study were female teachers (92.39%) with a mean age of 42.45 years (SD=10.50). The smallest number of participants came from Primorje-Gorski Kotar County (1.09%), while the largest number of participants came from Vukovar-Srijem County (23.91%). In addition, 40.30% of the participants stated that they come from a rural area and 47.83% of them work as a class teacher.

When it comes to participants' attitudes regarding the comparison with previous generations of students more than half of participants strongly agree that they are very different (53.26%), 39.13% strongly agree that they expect greater freedom of choice during the teaching process, more than half of them (59.78%) strongly agree that new generations of students have more difficult time accepting obligations and that they more easily use digital technology for private purposes (59.78%). Also, they somewhat agree that students use digital technology more easily for educational purposes (32.61%), prefer flexibility (39.96%) and personalized teaching content (36.96%). Only 6.52% of participants strongly disagreed with the statement dealing with today's students' greater ability to find accurate information in a digital environment and the same percentage of participants (6.52%) strongly agreed that today's students are more critical of information found on the Internet and are more aware of their

possibilities (6.52%). In addition, the lowest number of participants (1.09%) expressed strong disagreement with the statement regarding today's students overestimating their capabilities and the same percentage of participants (1.09%) strongly agreed that they underestimated their capabilities. The highest number of participants indicated that they are neutral concerning the belief that the newer generations are more tolerant (32.61%). The highest number of them disagreed (strongly 11.96% and somewhat 38.04%) that today's students are more willing to help their peers. Also, participants stayed neutral (41.30%) in the highest number concerning whether new generations of students like more to cooperate with their peers compared to the previous generations, as well as that they are more motivated to learn (34.78%), are more ambitious (36.96%), are faster in completing tasks (34.78%) and more independent (32.61%). Furthermore, participants strongly agree that today students expect more entertaining content in the teaching process (55.43%), prefer a faster change of activities during the teaching process (46.74%), expect immediate feedback (52.17%) and like to use digital technology in teaching (44.57%).

In addition, most participants agree (39.13% agree and 39.13% strongly agree) that they are more adept at using digital technologies than their students, that they provide individualized teaching content to students (36.96% agree and 19.57% strongly agree), that they use collaborative learning as a teaching method (46.74% agree and 17.39% strongly agree), critically question the information with their students (53.26% agree and 30.43% strongly agree), believe that their teaching is fun for the students (52.17% agree and 14.13% strongly agree), their teaching is characterized by a quick change of teaching activities (52.17% agree and 15.22% strongly agree), they use project teaching (32.61% agree and 14.13% strongly agree), they communicate with their students using digital technology (33.70% agree and 17.39% strongly agree), they use internet search engines with their students to find information (42.39% agree and 20.65% strongly agree), give their students instant feedback on their work using digital tools (34.78% agree and 8.70% strongly agree), give students the freedom to choose the way to complete a particular task (30.43% agree and 13.04% strongly agree) and expect students to collaborate with each other using digital technologies (45.65% agree and 16.30% strongly agree).

Most participants remain neutral regarding the statement that they should use debates in their work (40.30%). In addition, they most often agreed that the use of ICT positively influences the child's intellectual development (31.52% agree and 7.61% strongly agree), the development of technological skills (33.70% agree and 15.22% strongly agree) and the development of digital skills (38.04% agree and 27.17% strongly agree). However, they

disagreed that the use of ICT has a positive impact on physical development (35.87% strongly disagree and 38.04% disagree), social development (16.30% strongly disagree and 43.48% disagree), moral development (10.70% strongly disagree and 45.65% disagree), spiritual development (14.13% strongly disagree and 47.83% disagree), the development of language skills (18.48% strongly disagree and 33.70% disagree), the development of the ability to learn how to learn (6.52% strongly disagree and 30.43% disagree) and family upbringing (20.65% strongly disagree and 33.70% disagree). Only 6.52% of participants strongly agree that ICT use has a positive impact on the development of social and citizenship competences. They remained neutral in regards to the impact of ICT on the development of mathematical skills (41.30%), scientific skills (44.56%), the development of initiative and entrepreneurship (42.39%) and the development of cultural awareness and expression (39.13%).

More than half of participant strongly agree (56.52%) that achieving upbringing goals in classes is just as important as achieving educational goals and that raising children nowadays has become more challenging (61.96%), as well as that parents should be more actively involved in the activities that children spend time on using their digital devices (76.09%). Also, most of them agree (38.04% agree and 36.96% strongly agree) that upbringing goals in classes are often neglected.

For the development of the neural network, the target variable chosen was the variable for which the participants expressed their agreement with the effects on the development of social and citizenship competences. Participants' responses were categorized into those who had a negative attitude towards the impact of ICT on the development of social and citizenship competences (43.48%) and those who did not (55.43%). The  $\chi^2$  association test was used to detect the association of this outcome variable with other variables. At a significance level of 5%, an association was found with the following variables and they were excluded from the neural network model development process: today's students expect more entertaining content in the teaching process ( $\chi^2(2)=5.98$ ,  $p=0.05$ ), communicating with students using digital technology ( $\chi^2(4)=13.60$ ,  $p=0.009$ ), receiving immediate feedback on their work using digital tools ( $\chi^2(4)=12.46$ ,  $p=0.014$ ), giving students the freedom to choose the way to complete a particular task ( $\chi^2(4)=12.08$ ,  $p=0.017$ ), expecting students to collaborate using digital technologies ( $\chi^2(4)=11.95$ ,  $p=0.018$ ), positive impact of ICT on physical development ( $\chi^2(4)=10.27$ ,  $p=0.036$ ), social development ( $\chi^2(4)=12.51$ ,  $p=0.014$ ), moral development ( $\chi^2(4)=10.09$ ,  $p=0.039$ ), spiritual development ( $\chi^2(4)=20.00$ ,  $p=0.005$ ), linguistic competencies ( $\chi^2(4)=24.01$ ,  $p=0.00008$ ), mathematical competencies ( $\chi^2(4)=10.55$ ,  $p=0.032$ ), scientific competencies ( $\chi^2(4)=15.03$ ,  $p=0.005$ ), technological competences ( $\chi^2(4)=13.24$ ,  $p=0.010$ ),

learning how to learn ( $\chi^2(4)=42.20$ ,  $p=0.000$ ), development of initiative and entrepreneurship ( $\chi^2(4)=19.292$ ,  $p=0.0005$ ), cultural awareness and expression ( $\chi^2(4)=52.66$ ,  $p=0.0000$ ) and development of family upbringing ( $\chi^2(4)=11.01$ ,  $p=0.026$ ).

A multilayer perceptron (MLP) was used as the network type, with various architectural elements changed (the number of hidden neurons was changed from 8 to 25, the sum of squares or cross entropy was used as the error function, a logistic, a hyperbolic tangent and an exponential function were used as activation functions) to train, test and validate 200 neural network models, while the total sample was divided into three subsamples for training (70%), testing (20%) and validation (10%).

The best model used 18 neurons in the hidden layer, sum of squares as error function and hyperbolic tangent as the hidden activation function and obtained 77.77% of overall classification accuracy. It managed to correctly classify all teachers who believe that the use of ICT has a positive effect on the development of social and citizenship competencies and 60% of those who do not.

The three most important variables that contributed to the accuracy of the model were identified in the sensitivity analysis as variables examining teachers' attitudes toward the statements about current students' expectations for more entertainment content in the teaching process (1.92), immediate feedback (1.91), and their ambition (1.78).

## **Conclusion**

This paper addresses teachers' general attitudes towards today's students and their learning habits compared to the previous generations, teachers' attitudes towards their own teaching methods and the inclusion of digital technologies in their teaching, their views on the positive impact of ICT on different aspects of children's development and the development of different skills, and their views on educational goals and upbringing. The focus of the paper was on discovering relationships between different variables and teachers' attitudes that the use of ICT plays a positive role in developing social and citizen competencies. The neural network approach was chosen to uncover the underlying patterns. The best neural network model developed was able to accurately (overall classification accuracy of 77.77%) categorize all teachers who believe that the use of information and communication technology has a positive impact on the development of social and citizen competences.

Insight into the relationship between teachers' attitudes towards ICT and the development of social and citizenship skills can facilitate the development of approaches that successfully incorporate technology into teaching practices. Teachers who have a positive

attitude are more likely to use and utilize ICT tools with enthusiasm, which contributes to enhancing students' learning experiences. Teachers who have a positive attitude towards ICT are also more likely to be motivated to incorporate interactive and collaborative digital tools into their teaching. This approach promotes the development of skills such as communication, teamwork, critical thinking and digital literacy among students. In addition, understanding the relationship between teacher attitudes and the use of ICT to promote social and citizen competencies could provide valuable information for the development of targeted professional development programmes. These programmes aim to address teachers' barriers or fears about incorporating technology, thus enabling them to use ICT more effectively in the classroom. Finally, a positive attitude towards technology can foster a learning environment where students are actively engaged, motivated and have the skills that are essential for success in a digital and connected society.

Although notable links were found between teacher' views on the use of ICT and the development of social and citizenship competencies, it is important to recognize the limitations of this study. Key limitations of the study include a limited sample size of participants and insufficient inclusion of male teachers, which may affect the generalizability of the findings. Suggestions for future research include expanding the sample of teachers, with a focus on including male teachers to obtain a more accurate understanding of attitudes towards ICT. In addition, it is desirable to include teachers from different states with different educational frameworks or alternative data mining methods, such as decision trees, to further explore the links between variables and gain a more comprehensive understanding of how teacher' attitudes affect students' skill development.

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## **The Influence Of Technology On Improving The Learning Of Literature In High School Students**

Vjollca Osja and Edlira Macaj

University of Tirana, Department of Literature, Albania

### **Abstract**

This paper aims to highlight the influence and active role technology plays in the educational process of young people in high schools. The specific objective is related to innovative methods that can be applied to improve the teaching and learning of literary works or processes within this age group, considering both current teachers and students in the field, as potential teachers. Therefore, a questionnaire directs the research questions to the main two focus groups (teachers and young students). This quantitative methodology analyses the current situation, possibilities, and tendencies of where reading can go and how reading as a process and interpretation as a method of understanding and analysing literature can be assisted. Data processing factors in finding the tendency that the younger generation is inclined towards technological facilitation, the necessity for teachers to be trained, and the innovative models experimented with by students, serve as evidence for a new approach to literature. In conclusion, this situational detection supports the hypothetical idea that if we approach technological tools as aids to bring young people closer to modern theories of learning, then each of the actors involved in the process finds themselves playing their role. Thus, the educational process is aided by technology to reshape traditional learning towards new forms of communication.

*Keywords:* technology, education, influence, approaches, resizing

### **Introduction**

Nowadays the development of technology has significantly increased the possibilities and means of information, reading, and communication. Therefore, there is a need for their use in the educational process. This is because technology is not only an essential indicator in various fields such as economics, social sciences, medicine, etc., but it is also essential in education due to the facilities it creates in this process. Despite ongoing debates among researchers about the advantages and disadvantages of its use, the development of technology and its extensive expansion in all these directions have also increased the possibilities along

with the challenges of implementing new methods in the teaching and learning process of literature. Today, digital infrastructure is considered as a good opportunity to improve students' affinities with books in all of their possible formats.

In practice, digital technologies offer new learning environments that "create another kind of relationship between teachers, students, and what is being learned" (Laurillard, 2013). Therefore, the orientation towards the constructive use of technology in the teaching process in general, and that of literature more specifically, is becoming an imperative for our high schools. Furthermore, at a time when the request for reading in the age groups we focus on has significantly decreased<sup>1</sup>, encouraging this habit of reading specific works that are part of curricula or of a *gratia sui* (works that are read for pleasure) (Eco, 2001:23), makes it mandatory to explore new digital methods, in addition to the classical ones, for teaching literature.

Therefore, examining how digital technology can support the teaching process of literature (through digital platforms, audiobooks, social networks, educational games, virtual reality, digital storytelling, argumentation methods illustrated with schemes, diagrams, graphic systems, argument maps, VEE diagrams, multimedia, literary vlogs, literary chats, etc.) to improve learning outcomes, awaken interest and pleasure in this subject, and enhance critical and creative thinking skills, constitutes one of the main interests of this paper. Information processed from a survey directed to teachers and students of high schools in several cities in Albania becomes the main measuring instrument to draw some important conclusions related to improving the quality of learning when innovative methods intersect with traditional ones.

## **Literature review**

Education and digital skills have now become an inseparable duo, especially for this generation growing up in the digital age. Researchers have also pointed out that alternating between reading in print and digital multimedia sources increases students' interest and engagement in the learning process, making the lesson more attractive and enhancing interactive participation in the learning process (Belli & Alonso, 2021, p.9). European international strategies guide where and how educational development should be focused. Even countries like Albania, in their national strategies and policies, echo this general spirit. The educational spectrum tends towards diversity, interdisciplinarity, and quality<sup>2</sup>.

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<sup>1</sup> [https://spectrumlocalnews.com/nys/hudson-valley/education/2023/10/30/research-finds-decrease-in-teens-who-read-for-pleasure?cid=share\\_clip](https://spectrumlocalnews.com/nys/hudson-valley/education/2023/10/30/research-finds-decrease-in-teens-who-read-for-pleasure?cid=share_clip)

<sup>2</sup> Pre-university education in Albania operates based on the Education act (Act, 2012). In Article 13 of the updated version of this Act on pre-university education (2015), it is important to learn through basic competencies such as communication and expression; thinking; critical evaluation; digital skills, etc. In this framework of development, the didactic interest to activate methodological innovations in the

Within this framework of development, the didactic interest in activating new methodological approaches in the teaching and learning of literature in our classrooms increases every day. Technological development aids in the concept of inclusivity in the context of global education but also in the cultural context (Case, 1993, pp. 318-325). To stimulate new approaches by using the advantages of technology such as access to various forms of materials, real-time interaction in multiple ways, visual advantage, embodied ideas and theories, time efficiency, and more, we can consider their concrete impact in a case study with the participation of teachers/students concerning traditional and technological methods for teaching/learning literature. This way comes naturally for young people who have the greatest affinity with this environment, which they also use for their social and personal activities (Brown, 2002, pp. 65-91). To ensure their professional success in this habitat, teachers must live together with them in an atmosphere of freedom and creativity.

The use of technologies in teaching implies an awareness of global dynamics and a readiness to recognize alternatives. It involves developing analytical, selective, and evaluative skills, among others (Hanvey, 1976). If we consider technology as a tool to realize the potential of electronic learning, this choice of practice requires us to rethink our pedagogy, starting from ideas. Even in universities, educational experiences and passive approaches to information are in contrast to the interactive and constructive potential of electronic learning (Garrison & Anderson, 2003). New methods offered by technology also stimulate interactivity as a trend of contemporary education supported by theories such as generative, which encourages students to combine new information with existing one (Grabowski, 2004, pp.719–743); cognitive flexibility, which develops students' critical and creative thinking abilities (Spensley & Taylor, 1999, pp. 300-324); and reflection, where students engage themselves intellectually and emotionally (Schön, 1983). All of these theories live through technological tools in resultative practices related to the effectiveness of technology in didactic practices (Duffy, Lowyck and Jonassen, 1993), and in ensuring students' participation (Naismith et al., 2006).

### **Research methodology**

This study aims to highlight how and to what extent digital technology methods are involved in the process of teaching literature in our secondary schools. It also aims to emphasize the assistance and active role that technology plays in the educational process of young people

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teaching and learning of literature in the auditoriums of our schools increases every day. Retrieved from: <https://arsimi.gov.al/wp-content/uploads/2019/02/Pligj-parauniversitari-i-azhornuar.pdf>

in this age group. The research is structured using a qualitative approach that includes explanation, analysis, and description, alongside a quantitative approach focusing exclusively on recording data from concrete measurements, analysed and interpreted through diagrams.

### **Instruments**

To achieve the above objective, there are used two specific questionnaires, each consisting of 10 questions, to assess the teaching/learning of literature concerning technology. Both questionnaires were addressed to teachers and students, as direct interest groups, and then their responses were organized and analysed. The questionnaires were administered in a way that each participating student and teacher could complete them individually after being briefly explained the purpose of the survey and by securing their anonymity. They include open-ended questions, Likert scale assessments, as well as questions that record suggestions from the interest group. The questions are primarily based on the use of digital tools in the teaching process of literature, as well as the current state of artistic books and the reading process in our schools. In general (with few exceptions), questions with alternative answers were used to ensure more concise data. The survey aimed to ascertain: how equipped our schools are with technological infrastructure and whether they are effective in the teaching process; how teachers deal with and use digital resources during literature classes, and how much active training to improve their knowledge of technology they undergo.

### **Data collection**

Besides the explanation part of the literature review that treats the issue of education and digital skills, more concretely, how and to what extent digital technology methods are involved in the process of teaching literature, this research utilized another instrument to collect concrete data from the two focused groups. It is a quantitative research approach that supports the necessity of collaboration between the learning competence and digital skills of the young generation.

The survey was conducted using a Google Form questionnaire, and the link was distributed to teachers and students via email and WhatsApp. The questionnaire was chosen as an appropriate method to standardize the entire process with the same questions for students and teachers. In this survey, 277 students and 81 teachers participated. The survey was interesting to find out what the situation of teaching and learning literature is. How do teachers and students build interaction? What is the difference between traditional and innovative ways of knowing literature and how can technology help to better assess the information and raise the quality of reading?

## **Findings and discussion**

Some of the questions addressed to students were: the concrete possibilities of using computer infrastructure (computer base, tablets, digital screens) during class hours; and whether they think the use of new technologies (e-books, platforms, computer programs) could make teaching and learning literature more beneficial; whether teachers used materials that require new technology support (websites, audiobooks, online museums, digital libraries, etc.) during literature classes; whether their school library met the needs of students regarding literary works included in the school curriculum; about the frequency of working with e-books or audiobooks and if they could list any website used for learning purposes. They were also asked if they were familiar with them and with which ones. The other part of the questions is related to gathering opinion information, mainly of the students in this case, if they would find it appropriate for electronic games, movies, audiobooks, social networks and other electronic communication tools to be transformed into interactive opportunities to engage with literature. Respecting the nature of these questions, the teachers' questionnaire tested their specific practices, specifically whether they offered their students such practices and to detect what their frequency was.

## **Data analysis**

The survey dedicated to teachers and students aimed to measure: a. the ability of literature teachers to effectively use digital devices and tools during the teaching process - in terms of quality; b. students' interest in seeking alternative information about literature on websites, and well-known and secure platforms; students' ability to adapt to other forms of reading besides traditional literature; c. the level of usage of various apps that transform literary texts into multimedia formats; d. the opportunities offered to the teachers to train them in considering how classical pedagogical methods can be adapted to new techniques that require the use of digital resources because "The most effective schools and teachers are more likely to use digital technologies more effectively than other schools and teachers" (Higgins, Xiao & Katsipataki, 2012).

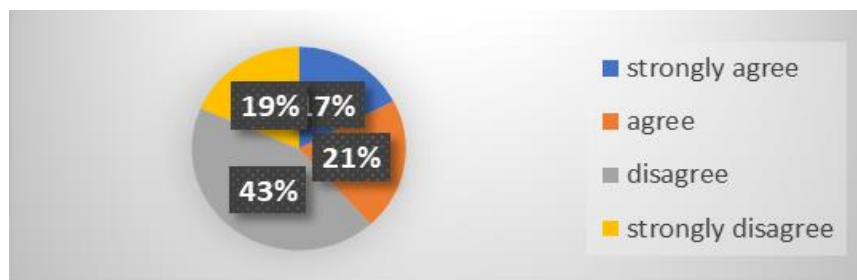
## **Research results**

### **1. Teachers**

Before assessing the situation of interaction with new innovative instruments during the literature classes it is important to get information regarding technological infrastructure supporting the teaching and learning process, especially because the teacher needs to implement new methodologies in teaching literature, the survey shows that we are far from what it should

be. About 61.7% of teacher respondents (more than half of the teachers), whose responses are illustrated in Figure 1, expressed that in the school where they teach, there is little (43% of respondents) or no (19% of respondents) technological infrastructure at all. As shown in the chart below, only 17% are satisfied with the technological base they have, while 21% of teachers see the technological infrastructure provided by the school as sufficient.

Schools are not at the same level or performance as they do not possess the same technological conditions. Some schools may have specific labs, where young students can make or create projects and have success at creative works, another part identified a group of schools that miss this infrastructure and this fact conditions the students' opportunities to be active. They might want to use innovative methods but they cannot due to the lack of the appropriate infrastructure.



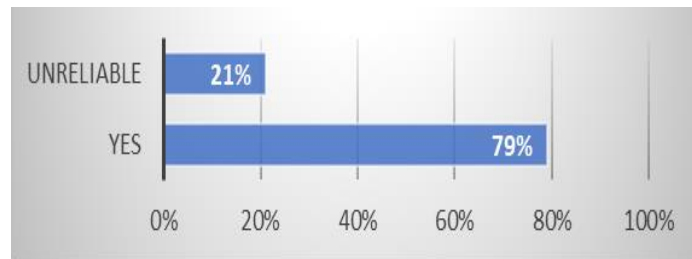
**Figure 1** School's technological infrastructure

Meanwhile, as the answer to the question of whether they see the use of new technologies in the teaching and learning process of literature as useful and effective, the data says that 80.2% of teachers responded positively - which is a good indicator of teachers' predisposition to be open to new methodologies in teaching - and only 19.8% of them have doubts and reservations.



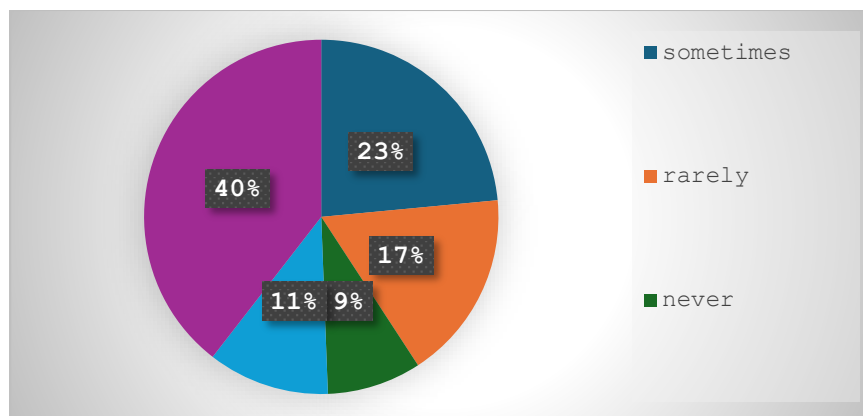
**Figure 2** Effective use of technology

Continuing this argument, in response to the following question, teachers, to a relatively large extent, acknowledge the effectiveness of using three competencies (digital, critical thinking, and creative thinking) using digital technologies. 79% of them believe that integrating these three competencies using digital technology enhances the quality of literature teaching, thereby increasing the interactivity and creativity of students. Only 21% of them are unsure. This is presented in Figure 3.



**Figure 3** Competence efficiency assisted by technology

However, even though teachers see the use of digital methods as beneficial, the complete or partial lack of technological tools in our schools, as well as the lack of continuous training to make teachers more proficient in using new technologies in teaching, indicates a somewhat unsatisfactory situation. When asked how much technology they have utilised to support the teaching process, almost half (about 51%,) of the responded teachers admitted to using technology (often 40% and always 11% of respondents), while the others responded: sometimes (23%), rarely (17%) or never (9%) in teaching (see Figure 4.).



**Figure 4** Use of new technology for teaching literature

## 2. Students

The second target group aimed at in this survey were the students, as one of the two significant components in the process of learning literature. Thus, a high percentage of the

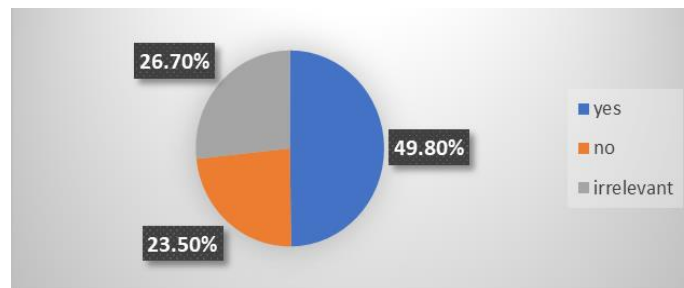


surveyed students believe that the use of new technologies in the teaching process of literature can make it more beneficial. The number of students who admit that they would support the use of technology in the teaching process of literature is impressive, but also such a response was expected, considering their connection with digital technology. However, referring to the collected data from the students' survey, the situation regarding the proficiency of teachers and the provision of schools with digital infrastructure is not the same. Regarding the question of whether teachers in our schools support the teaching process with new teaching technologies (digital libraries, audiobooks, online museums, multimedia tools, etc.) to engage students in the subject, the responses of the students suggest that we are far from what is expected, as the data in Figure 5 show. The majority of surveyed students chose alternatives such as occasionally (26.7%), rarely (18.4%), or never (20.2%), while only 34.7% of students have responded positively (specifically, 13% always responded always, and 21.7% responded often).



**Figure 5** *Use of new technology for learning literature*

Considering that today, globally, digital resources are increasingly suggested as a good alternative and easily accessible base to enrich the teaching classes with additional literature, it was expected that they would also find use here. However, from the gathered data, it turns out that we are far from this trend. Digital books, audiobooks, or other digital tools are still not assessed as an alternative source that helps provide students with reading as a process and literature as part of the curriculum. Thus, to the question of whether the use of the digital book improves/assists teaching and provides the student with literature as a subject, only 49.8% believe that it does, while the rest, which is slightly more than half, 50.2%, believe the opposite. Specifically, 23.5% think using digital books does not improve the situation, and 26.7% do not see any significant difference with the use of digital books. These data indicate that we are still far from alternating classic methods with new, contemporary methods of reading literature. These findings are illustrated in Figure 6.



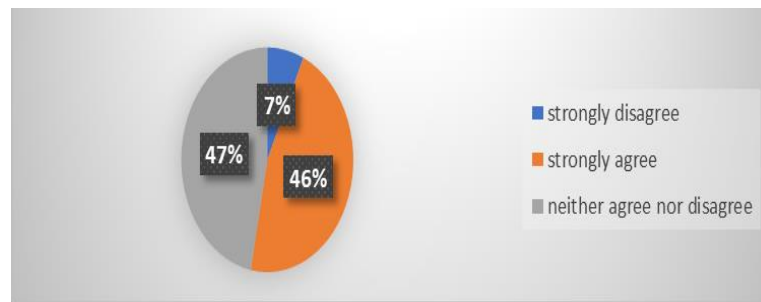
**Figure 6** The impact of digital books on the learning of literature

Regarding the use of various websites as sources to find supporting materials for the literature as a school subject, the vast majority of surveyed students, about 81.2%, mentioned *Wikipedia* as the main reference source, while the portion that did not use any website constitutes only 5.1%. Between these two extremes, there are choices such as *online encyclopedias* 7.6% (21 students); *Ted Talk* 1.8% (5 students); and 4.3% (12 students) utilised *various website pages*. Certainly, the inclination of students towards *Wikipedia* - a quick but only informative source - demonstrates their tendency to seek more information rather than knowledge itself (Eco, 2001).



**Figure 7.** Usage of online pages

The data from the responses to the last question, which concerns the appropriateness of students using electronic games and other electronic instruments for the literature class, and transforming them into an opportunity to make the process of teaching and learning literature more interactive, are highly significant. Out of 277 surveyed students, only 6.9%, or 19 students, exclude the possibility of using games for the literature class, while the rest accept it. About 46.2% unequivocally support the idea, while 46.9% accept it but suggest that it should be done with the proper effort. These findings, illustrated in Figure 8, demonstrate that electronic games (such as *Fortnite*, escape rooms, etc.) which are so attractive and beloved by adolescents, can be transformed into educational tools, becoming a good way to increase interactivity and imagination, and also a good opportunity to engage them with literature.



**Figure 8.** Use of technological tools (videos, edugames, books, nets ...) for literature

## Discussion

According to the analysed data, it is clear that the use of digital technologies is needed in the teaching and learning of literature. It improves the quality of learning and makes literature as a school subject more attractive for students. Teachers highly acknowledge that the use of new technologies can make the teaching and learning of literature more beneficial and attractive. Additionally, around 80% of teachers believe that the integration of three competencies (digital, critical thinking, and creative thinking) using digital technology enhances the quality of literature teaching.

An impressive number of students also think the use of new technologies in the teaching of literature is something beneficial. At the same time, social media platforms such as Instagram and Wikipedia are the most used sources by students to find supportive materials for literature. Over 90% of students see transforming electronic games, movies, audiobooks, social media, and other media into interactive tools to approach literature as appropriate. These conclusions demonstrate the need for and value of using digital technology in teaching and learning literature. We are aware that there are still many aspects of the impact of technology on improving literature learning among secondary school students that need further analysis, and there are also many reasons why we should use technology in teaching literature. We hope to address these aspects in other papers.

## Conclusions

Nowadays it is obvious that technology has changed the ways education explores knowledge. It influences improving the learning of literature among high school students by shifting the whole process from traditional to innovative teaching and learning interaction. Teachers should be more flexible to new approaches and young students can easily find new paths to explore artistic works. Both of them should be prepared for the new global perspective

in education. Using digital skills of both focus groups can improve literature learning with new approaches facilitated by technology.

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- <https://arsimi.gov.al/wp-content/uploads/2019/02/Pligj-parauniversitari-i-azhornuar.pdf>

## **The Use Of Digital Tools Among Students At Class Teacher Studies During Teaching Preparation And Performance**

Suzana Tomaš<sup>1</sup>, Alma Škugor<sup>2</sup> and Alena Letina<sup>3</sup>

<sup>1</sup>Faculty of Humanities and Social Sciences, University of Split, Croatia

<sup>2</sup>Faculty of Education, University of Osijek, Croatia

<sup>3</sup>Faculty of Teacher Education, University of Zagreb, Croatia

### **Abstract**

Digital tools include various apps, software, and platforms used to facilitate, improve, and advance different processes. They provide a wide range of possibilities to improve teaching process, by enabling interaction, personalization and efficient learning. Digital tools are used more often as they present an integral component of a teaching process. The paper analyses the use of digital tools among students at class teacher studies during public lessons preparation, and performance. The goal of this research is to identify digital tools used by students of class teacher studies while preparing and implementing public lessons, and to define the context and phases digital tools are used in, as well as the frequency of use. The research was implemented by disseminating a questionnaire among students studying at the fourth and fifth year of class teacher studies at the universities of Split, Osijek and Zagreb. The questionnaire was drafted for the needs of this research. The research results enable better insight into the diversity of digital tools used by students in the process of preparing and delivering their public lessons. Apart from the mentioned, the research results contribute to a better understanding of the digital tools use in educational process, and they provide guidelines for the improvement of the education incorporating digital tools.

*Keywords:* digital tools, public lessons, class teacher studies students

### **Introduction**

Digital age, which characterizes our daily life, enables the technology to play an important role in the context of education. Teachers recognize the need for the implementation of digital tools in the teaching process, thus enabling the students to have wealthier, more interactive, and personalized learning experience. Considering this trend, it is especially important to study the way digital tools may be of use to students that are future teachers, in

preparing, and delivering lessons in practice schools throughout their formal education at class teacher studies.

Digital tools may have various uses in education, and they can include many different teaching aspects. Digital tools enable teachers and students to communicate, cooperate, and access teaching resources without having to be physically present in the classroom. Distance learning platforms, such as Google Classroom, Moodle or Microsoft Teams, provide teachers with the possibility to set tasks, share learning materials, manage online discussion and evaluate students' works. Interactive lessons promote students' active participation in the process of learning, while tools such as Nearpod, Quizizz, Quizlet or Edpuzzle enable teachers to create interactive presentations, quizzes, group activities, and comprehension checks which the students might access on their devices. Apart from the mentioned, digital tools provide students with the possibility to express themselves creatively, and to develop multimedia content. For example, tools such as Canva, Adobe Spark or Book Creator serve for the development of digital presentations, posters, videos, digital stories or books which might be shared among students. Students often use tools such as Google Docs or Microsoft OneNote to cooperate on projects, exchange ideas, monitor improvement, and exchange feedback. Digital tools provide teaching content, practice, and knowledge checks which are adjusted to individual learning speed, and interests of each individual student.

Nowadays, we are facing unique characteristics of Generation Z, which grew up in digital world where immediate access to information presents a standard. Millennials and Generation Z, who have significantly changed their communication patterns and the way they form interpersonal relations, increasingly use digital tools and actively participate on social media (de Castro et al., 2022). Therefore, students have no choice but to adjust their teaching methods, and offer content which is to be delivered in another modality. Generation Z students often describe themselves as boring and distracted when they are not using several sources of information simultaneously. Their attention span is significantly shorter than the attention span of Millennials, and they have greater desire for immediate responses and information (Shatto and Erwin, 2016). Despite the above mentioned, this new generation of "digital natives" actively takes part in the learning process (Giray, 2022). Although they demonstrate impressive knowledge of technology, and capability for independent learning, they have to be encouraged to develop critical thinking. They have practical and powerful tools such as smart phones, tablets and computers at their disposal (Green et al, 2021). These devices tend to make the integration of interactive apps into teaching easier. However, face-to-face teaching still

dominates and many teachers do not seem to be ready for online teaching (Martín-Sómer et al., 2021; Romero et al., 2021).

Active use of digital tools in teaching is the key for the education of future teachers in digital environment. It is extremely important to ensure that the future teachers are capable of efficiently implementing technology in digital process, with the goal of providing quality educational experience to their students. Ensuring successful education of future teachers in digital environment requires the implementation of digital tools in the teaching programmes at teaching studies, including the curriculum of the courses focusing on the use of technology in teaching. Apart from the mentioned, it is necessary to plan workshops and/or seminars providing future teachers with real experience in the field of working with digital tools. These activities can include the use of interactive presentations, online communication and cooperation platforms and tools intended to create digital content. By ensuring support to future teachers during their education in digital environment, one sets the base for successful integration of technology in the teaching process. Educating future teachers to use digital tools requires a systematic approach involving integration, practical experience, support, evaluation and creating encouraging environment. This is the only way to ensure that the future teachers are ready and capable to successfully manage digital lessons. One of encouraging projects for both the schools and the students at teacher studies is the project of e-Škole. The aim of the project is a systematic and regular use of technology in teaching and education, suitable infrastructure, and computer equipment in all schools in Croatia, as well as developed educational and digital content. The project which digitally transformed teaching and business processes in all schools in the Republic of Croatia lasted for 8 years (from 2015 to 2023) (<https://www.e-skole.hr/program-e-skole/>). Via e-Škole project, the teachers of the future have the opportunity to see specific application of digital tools in real educational environment. The students at class teacher studies could see the examples of the digital tools usage in creating, and adjusting digital and educational content, as well as the way these contents contribute to improved learning process among students, by using open digital and educational content (<https://edutorij.carnet.hr/>). This encouraging project inspires and guides students at class teacher studies as how to use digital tools during their future career. By analysing such projects, the students can develop deeper understanding as regards to the importance of digital technology in education, and gain practical knowledge and skills needed in order to successfully integrate digital tools in their future teaching.

Digital age creates new perspectives in education, and the application of digital tools has become a requirement in the modern educational context. The integration of digital tools in

teaching process results in numerous advantages in the sense of improving teaching quality, individualized approach to learning and encouraging cooperation. Therefore, this paper aims to research the application of digital tools among students at teacher studies during the process of preparing and delivering public lessons within methodological practice in schools.

Classroom teaching provides direct learning environment, enabling faster evaluation and greater students' engagement, especially when the teaching process is adjusted to their individual needs. If digital tools are used to prepare teaching process, the teaching process itself becomes more interactive and adjusted to each individual. Within the process of preparing and implementing teaching, it is necessary to select suitable digital tool which shall support efficient learning and students' engagement. The selection of the right tool requires careful analysis of tool features in accordance with the lesson goals and students' needs. Considering the diversity of digital tools available at the market, it is crucial to find digital tools which correspond to specific requirements of the teaching subject and methods.

An increasing need for digitally competent teachers emphasizes the importance of continuous improvement of their skills during the integration of technology in teaching, and learning (Instefjord & Munthe, 2017; Ng, 2012). Teachers play crucial role in guiding students through digital technology in education. Therefore, it is an imperative that students, who are future teachers, possess digital competences and pedagogical skills needed to successfully integrate digital technology in teaching (Instefjord & Munthe, 2017). Having this in mind, it has to be stated that education during studies has a key role in improving digital competences of future teachers, as it is acknowledged in the OECD guidelines (2017).

Students at class teacher studies increasingly use digital tools in order to improve teaching preparation process and in order to implement their public lessons in a quality manner. The use of digital tools enables easier preparation of teaching materials, simultaneously encouraging creativity and innovation in teaching and learning (Lao et al., 2018). Digital tools are becoming an inevitable part of the support to the teachers' professional development, enabling their cooperation and reflexion despite geographical distance (Hrastinski, 2021). Furthermore, the development and evaluation of digital tools used for teaching are crucial for the promotion of applicable knowledge during teachers' education process, assisting students to prepare for the modern teaching requirements (Reichert-Schlax et al., 2023). In the age of networking, the teachers have the possibility of using the potential of digital tools in order to make the teaching content efficient and available to everyone, regardless the time and place (Carvalho et al., 2022). The role of digital technology in education is not limited just to the support to the teachers during lessons preparation procedure. Just the opposite, due to its



potential, it significantly improves the teaching process (Haleem et al., 2022). The implementation of digital tools transforms education, making it more dynamic and accessible, to both teachers and students.

## **Research methodology**

### *Research goal*

The goal of this research is to identify digital tools and contents used by students at class teacher studies while preparing and delivering public lessons, as well as to define the context, phases, and the frequency of their use.

### *Research questions*

1. Which digital contents are used by the students at class teacher studies while preparing their lessons and how often?
2. Which digital contents are used by the students at class teacher studies while implementing public lessons and how often?
3. Is there any statistically significant difference in the application of digital tools among students at class teacher studies considering their place of study?
4. What teaching subjects do students most frequently use digital tools in?
5. Is there a difference in the application of digital tools in the following subjects – Maths, Croatian Language, Science, Art, Music, PE, Foreign Language, and IT – among students considering their year of study?
6. What is the context in which the students most frequently use certain digital tools?

### *Instrumentation*

A questionnaire according to the online source of SURF (2021) was made for the purpose of this research. It enables the collection of information on the use of digital tools. The questionnaire may be used as an example for other target groups.

The questionnaire in this research has four parts. The first part of the questionnaire includes demographic questions. The second part of the questionnaire entitled *The Use of Digital Tools during Lessons Preparation and Implementation* includes 27 statements which question the extent to which the students use digital tools while preparing and implementing public lessons. The third part of the questionnaire entitled *The Preparation for the Lesson Implementation* includes the list of digital content used while preparing a public lesson. The fourth part of the questionnaire entitled *Public Lesson Implementation* is used to define to which

extent the students use digital content during public lesson implementation. Apart from the mentioned, it was established which digital tools and to what extent are used by the students when implementing a public lesson within certain subjects.

The respondents evaluated the frequency of digital tools use at the Likert scale consisting of 4 levels, 1 meaning never, 2 – sometimes, 3 – often and 4 – always. Cronbach Alfa was 0.93, and this indicates that the reliability of all scales is satisfactory (Table 1).

**Table 1.** Descriptive parameters at the sample of students (N=218)

Descriptive parameters at the sample of students (N=218)			
	M	SD	CRONBACH' ALFA
Scale	1.92	0.29	.93

### *Sample of respondents*

The research included the students studying at the teacher studies at the Universities in Osijek, Split and Zagreb. The respondents filled in the questionnaire on voluntary basis, anonymously and without receiving any fees. The research included 298 students in total. 218 students finished the questionnaire, and their results were further processed. The respondents included the population of the students studying at the fourth and fifth year of their studies. There were 46 students studying at the Faculty of Humanities and Social Sciences in Split, 69 students studying at the Faculty of Education in Osijek and 103 students from the Faculty of Teacher Education in Zagreb.

### *Procedure*

The research was implemented in the period from February to March 2024, online, by distributing a questionnaire entitled *The Use of Digital Tools while Writing the Lesson Preparation and while Implementing the Lesson*, which was drafted for the needs of this research. The questionnaire was distributed online. The purpose of the research was explained in the introductory part of the questionnaire, and the students were familiar with the possibility of giving up the participation in the research at any moment.

### *Results and Discussion*

In order to respond to the first research question stating *Which digital contents are used by the students at teacher studies while preparing their lessons and how often?*, we applied descriptive statistics procedure. Apart from the mentioned, in order to inspect whether there is any difference among students studying at teacher studies in relation to the study location, we implemented chi-square test as shown in the Table 2.

Total results N=218 in M (SD) present average grades and standard deviations in the usage of different contents while preparing for the public lesson implementation among students studying at the teacher studies in Osijek, Split and Zagreb. Average value is 3.03 (SD=0.87) for the use of digital textbook while preparing for the public lesson implementation (N=218) which indicates a moderate use of this content. High frequency of presentation usage while preparing for the public lesson implementation is indicated by the average value of 3.75 (SD=0.54). Standard deviations vary among students as regards to the frequency of the use of different contents during preparation for the public lesson implementation, depending on the place of student's study. The students studying at the class teacher study in Osijek tend to use digital textbook more while preparing for their public lessons than students studying in Split and Zagreb. On the other hand, students studying at class teacher studies in Zagreb use presentations and websites in creating a part of the teaching content, graphics and videos more while preparing for their public lessons.

**Table 2.** The frequency of using digital content while preparing for the public lesson implementation

Chi-squared test in order to indicate the difference in the usage of the above stated content while preparing for the public lesson implementation among students studying at the teaching studies in Osijek, Split and Zagreb (N=218)

Variable of the content during the preparation for the public lesson implementation	OS (N=69) M (SD)	ST (N=46) M (SD)	ZG (N=103) M (SD)	Total (N=218) M (SD)	Chi squared df (6)
Digital textbook	<b>3.48 (0.65)</b>	2.57 (0.86)	2.93 (0.87)	3.03 (0.87)	36.1**
Presentation	3.57 (0.52)	3.33 (0.51)	<b>3.68 (0.54)</b>	3.75 (0.54)	21.3**
Online course	1.23 (0.54)	1.28 (0.45)	1.18 (0.43)	1.22 (0.47)	7.14
Documents	2.24 (0.94)	2.46 (0.78)	2.44 (0.96)	2.44 (0.92)	6.59
App	2.29 (0.92)	2.00 (0.76)	1.99 (0.90)	2.09 (0.88)	13.3
Website	2.67 (0.93)	2.59 (0.74)	<b>2.80 (0.86)</b>	2.71 (0.86)	6.09*
Creating a part of	1.55 (0.75)	1.72 (0.65)	<b>1.77 (0.81)</b>	1.69 (0.77)	8.66*
Graphics	1.59 (0.82)	1.61 (0.61)	<b>1.70 (0.80)</b>	1.65 (0.77)	9.26*
Video	2.30 (0.73)	2.33 (0.70)	<b>2.40 (0.79)</b>	2.35 (0.75)	4.35*
Live video	1.10 (0.42)	1.17 (0.38)	1.12 (0.35)	1.13 (0.38)	7.30*
Animation	2.32 (0.81)	<b>2.33 (0.84)</b>	2.19 (0.75)	2.26 (0.79)	2.15*
Forms	1.54 (0.67)	<b>1.61 (0.61)</b>	1.53 (0.66)	1.55 (0.65)	2.73*
Quizzes	2.90 (0.59)	2.59 (0.61)	2.45 (0.76)	2.62 (0.71)	20.8
Interactive content	2.87 (0.66)	2.46 (0.72)	2.59 (0.83)	2.65 (0.77)	14.0
Mind map	<b>2.10 (0.71)</b>	2.09 (0.72)	2.05 (0.80)	2.07 (0.75)	6.29*

Note: \*p<,05 \*\*p<,01

Second research question stating *Which digital contents are used by the students at class teacher studies while implementing public lessons and how often?* was analysed among students

studying in three different cities: Osijek, Split and Zagreb. The results were analysed using chi-squared test, and statistically significant differences in the frequency of the use of the above contents by the students considering their place of study were determined (Table 3).

**Table 3.** The frequency of the usage of the above stated contents during the public lesson implementation

Chi-squared test in order to indicate the difference in the frequency of the usage of the above stated content during public lessons implementation among students studying at the teaching studies in Osijek, Split and Zagreb (N=218)

Variable of the content during public lesson implementation	OS (N=69) M (SD)	ST (N=46) M (SD)	ZG (N=103) M (SD)	Total (N=2018) M (SD)	Chi squared df (6)
Digital textbooks	<b>3.13 (0.93)</b>	2.07 (0.71)	2.31 (0.96)	2.52 (0.99)	46.5**
Presentation	<b>3.49 (0.55)</b>	3.11 (0.67)	3.59 (0.61)	3.46 (0.63)	23.3**
App	<b>2.10 (0.87)</b>	1.80 (0.77)	1.83 (0.87)	1.91 (0.86)	7.53*
Website	<b>2.29 (0.92)</b>	2.15 (0.72)	2.13 (0.89)	2.18 (0.87)	8.16*
Video	2.36 (0.74)	2.46 (0.78)	2.15 (0.79)	2.28 (0.78)	12.8
Live video broadcast	1.07 (0.39)	1.22 (0.46)	1.16 (0.51)	1.14 (0.47)	13.7
Animation	<b>2.16 (0.83)</b>	2.07 (0.82)	2.03 (0.81)	2.08 (0.81)	4.58*
Interactive content	<b>2.70 (0.82)</b>	2.28 (0.77)	2.46 (0.90)	2.50 (0.86)	8.25*
Quizzes	<b>2.90 (0.66)</b>	2.67 (0.59)	2.35 (0.76)	2.59 (0.73)	29.5**
Interactive board	<b>2.29 (0.94)</b>	2.04 (0.81)	2.08 (0.95)	2.14 (0.92)	6.34*
Digital notebook	<b>1.64 (0.89)</b>	1.41 (0.65)	1.39 (0.71)	1.47 (0.76)	10.3*
Mind map	2.01 (0.75)	<b>2.07 (0.80)</b>	1.91 (0.88)	1.98 (0.82)	9.96*

Note: \*p<,05 \*\*p<,01

The results indicate that, out of the above stated digital contents, the students (N=218) most frequently use presentations (M=3.59, SD=0.61) during the implementation of their public lessons. Apart from the mentioned, digital textbooks (M=2.52; SD=0.99), interactive content (M=2.50; SD=0.86) and quizzes (M=2.59; SD=2.59) are used more frequently during public lessons implementation in relation to other digital contents listed in the Table 3. The results show that the students at class teacher studies in Osijek more frequently use digital textbooks, presentations, quizzes, interactive board, digital notebooks and mind maps when compared to the students from Split and Zagreb. On the other hand, students from Zagreb tend to use apps, websites and live video broadcast more often when compared to the students from Osijek and Split.

These results might correlate to the results of the studies specific for each class teacher study. In order to respond to the third research question that states *Is there any statistically significant difference in the application of digital tools among students at teacher studies considering their place of study?*, chi square test was used. It aimed to present the difference in

the frequency of the use of the selected digital tools among students at teacher studies in Osijek, Split and Zagreb.

During public lesson preparation and implementation, the students (N=218) most frequently use digital tools such as YouTube (M=1.61; SD=0.64), Wordwall (M=1.32; 0.88), Kahoot (M=1.23; SD=0.72) and Canva (M=1.07; SD=0.86). This preference can be explained by the fact that ready-to-use contents are available on YouTube and Wordwall, and they are easy to download and adjust to personal needs. Unlike in the case of the above mentioned tools, for the application of other digital tools, one needs to create their own content which may require more time and resources.

**Table 4.** Chi-squared test used in order to indicate the difference in the use of the selected digital tools among students at the class teacher studies in Osijek, Split and Zagreb during public lesson preparation and implementation (N=218).

Chi-squared test in order to indicate the difference in the use of the selected digital tools among students at the teaching studies in Osijek, Split and Zagreb (N=218)

Digital tools variable	OS (N=69) M (SD)	ST (N=46) M (SD)	ZG (N=103) M (SD)	Total (N=218) M (SD)	Chi squared df (6)
Google Classroom	1.49 (0.69)	<b>2.02 (0.71)</b>	1.25 (0.45)	0.49 (0.66)	48.1**
Canva	<b>2.23 (0.89)</b>	1.70 (0.72)	2.14 (0.86)	<b>1.07 (0.86)</b>	13.00*
ClassDojo	1.10 (0.30)	1.09 (0.28)	1.13 (0.36)	0.11 (0.32)	1.27
Edpuzzle	1.26 (0.56)	1.15 (0.36)	1.17 (0.37)	0.19 (0.43)	4.75
Facebook	1.28 (0.59)	1.24 (0.60)	1.15 (0.42)	0.20 (0.52)	5.05
Kahoot	2.35 (0.72)	2.26 (0.71)	2.16 (0.72)	<b>1.23 (0.72)</b>	3.33
Mentimeter	1.36 (0.64)	<b>1.74 (0.74)</b>	1.36 (0.62)	0.44 (0.67)	16.3*
Moodle	1.22 (0.51)	1.59 (0.74)	1.26 (0.54)	0.31 (0.59)	19.0
MTeams	1.07 (0.26)	1.17 (0.43)	1.13 (0.33)	0.11 (0.33)	5.27
NearPod	1.04 (0.20)	<b>1.26 (0.53)</b>	1.05 (0.21)	0.09 (0.32)	16.7*
Padlet	1.20 (0.50)	<b>1.39 (0.53)</b>	1.23 (0.46)	0.25 (0.49)	10.0*
Quizalize	1.25 (0.57)	1.24 (0.43)	1.24 (0.49)	0.24 (0.50)	4.92
Quizlet	1.65 (0.72)	<b>1.91 (0.66)</b>	1.60 (0.70)	0.68 (0.70)	9.86*
Quizizz	1.58 (0.71)	<b>2.28 (0.62)</b>	1.65 (0.72)	0.76 (0.74)	32.4**
Socrative	1.20 (0.50)	1.02 (0.14)	1.13 (0.36)	0.12 (0.38)	8.96
Youtube	2.59 (0.62)	2.63(0.61)	2.62 (0.67)	<b>1.61 (0.64)</b>	2.08
Wordwall	<b>2.80 (0.73)</b>	1.91 (0.69)	2.18 (0.91)	<b>1.32 (0.88)</b>	38.2**
Genially	<b>1.94 (0.76)</b>	1.35 (0.52)	1.14 (0.44)	0.43 (0.67)	71.4**
Powtoon	1.06 (0.23)	<b>1.33 (0.51)</b>	1.03 (0.16)	0.10 (0.31)	30.1**
Prezi	1.58 (0.77)	<b>1.85 (0.69)</b>	1.47 (0.72)	0.58 (0.74)	18.0*
Coggle	1.12 (0.47)	1.04 (0.20)	1.09 (0.37)	0.08 (0.38)	4.04

Note: \*p<.05 \*\*p<.01

Table 4 clearly underlines that there is a difference in the use of digital tools among students at the class teacher studies in Osijek (OS), Split (ST) and Zagreb (ZG). It can be noticed that the

students at class teacher studies in Osijek tend to more often use tools such as Canva, Wordwall and Genially, in comparison with their colleagues in Split and Zagreb.

On the other hand, the students at the class teacher studies in Split have a greater tendency of using digital tools such as Google Classroom, Mentimeter, NearPod, Padlet, Quizlet, Quizizz, Powtoon, and Prezi, when compared to the students in Osijek and Zagreb.

The answer to the research question stating *What teaching subjects do students most frequently use digital tools in?* is shown in the Table 5. With the selected teaching subject, the students stated the digital tool used.

**Table 5.** The overview of digital tools used by the students in certain teaching subjects

Digital tool	School subject							
	Maths N=218	Croatian Language N=218	Science N=218	Art N=218	Music N=218	Physical Education N=218	Foreign languages (English, German) N=218	Computer Science N=218
Canva	5	10	8	14	11		2	
Geogebra	6							
PowerPoint	<b>41</b>	<b>37</b>	<b>35</b>	<b>63</b>	<b>59</b>		<b>11</b>	<b>22</b>
Wordwall	23	17	24	4	6		5	7
Digital	<b>25</b>	<b>24</b>	<b>18</b>	<b>10</b>	<b>10</b>	<b>20</b>	<b>7</b>	<b>8</b>
Youtube	<b>3</b>	<b>11</b>	<b>19</b>	<b>45</b>	<b>57</b>	<b>8</b>	<b>7</b>	<b>14</b>
Digital	19	21	30	9	8		21	19
Total	122 (55.96%)	120 (55.04%)	134 (61.46%)	145 (66.51%)	151 (69.26%)	28 (12.84%)	53 (24.31%)	70 (32.11%)

The results indicated that PowerPoint presentations are the most frequently used digital tool in almost all school subjects. Digital textbooks and YouTube were used in all subjects. Wordwall is the most frequently used tool in Science, while Youtube is preferred in Music and Art. GeoGebra is used only in Maths. Other authors (Mollakuqe et al., 2020; Dahal et al., 2022) recognize GeoGebra as an exceptional tool used for the visualization of mathematical formula, algebra and geometric presentations. They recommend encouraging students to use this tool in order to improve the understanding of the mathematical concepts.

Such diversity and specificity in implementing digital tools in teaching emphasizes the importance of adjustment to the needs and specificities of each subject.

With the aim of responding to the fifth research question, the differences in the application of digital tools in school subjects such as Maths, Croatian Language, Science, Art,

Music, Physical Education, Foreign Language, and Computer Science were researched among students at class teacher studies, taking into consideration their year of study. It was noticed that the students (N=218) most often use YouTube which suggests that this tool is the most popular. This corresponds to the global trend identified via research and presented at the following website: <https://www.toptools4learning.com/>. In accordance with the above mentioned research and website, YouTube is ranked as one of the most popular digital tools used for learning. YouTube is ranked first as a digital tool. Therefore, we can conclude that it plays an important role in education and teaching, not just among teaching experts, but also among future teachers. Thus, the integration of YouTube and similar platforms in teaching practice may be a useful strategy to improve learning and teaching experience in school environment.

Implemented t-tests considering the year of study are shown in the Table 6.

**Table 6.** *t*-test indicating the difference in the use of digital tools in subjects between the year four students and year five students

Independent t-test implemented at the sample of students (N=218)

School subject	Fourth year of study (N=124) M (SD)	Fifth year of study (N=94) M (SD)	t (df)
Maths	0.40 (0.49)	<b>0.76 (0.42)</b>	5.70 (216)*
Croatian Language	0.38 (0.48)	<b>0.76 (0.42)</b>	5.99 (216)*
Science	0.40 (0.49)	<b>0.89 (0.31)</b>	8.46 (216)*
Art	<b>0.73 (0.44)</b>	0.57 (0.49)	2.49 (216)*
Music	0.73 (0.44)	0.63 (0.48)	1.52 (216)
Physical Education	0.10 (0.30)	0.16 (0.36)	1.19 (216)
Foreign Language	0.21 (0.40)	0.28 (0.45)	1.32 (216)
Computer Science	0.26 (0.44)	<b>0.39 (0.49)</b>	2.01 (216)*

Note: \*p<.05

While analysing the results, we noticed significant differences between the year four respondents (N=124) and five (N=94) as regards to the use of digital tools in certain school subjects.

There is a statistically significant difference between the year four and five for the subjects of Maths, Croatian Language, Science, and Art. Year five students tend to use more digital tools in Maths, Croatian and Science than year four students. On the other hand, year four students tend to use more digital tools in Art than Year five students.

In order to respond to the sixth research question, analysis of variance was implemented and the difference in the use of digital tools per stages of public lessons implementation was

determined. Digital quizzes proved to have the greatest statistical significance in the phase of practice and revision ( $F = 21.934$ ,  $p < .001$ ), and students use them significantly in the evaluation phase as well ( $F = 6.254$ ,  $p = 0.003$ ). The use of digital games in the context and in accordance with the lesson phases did not indicate statistically significant differences. The students use digital games equally, regardless public lesson implementation phase. In the phase of practice and revision ( $F=7.168$ ,  $p = 0.001$ ) and in the phase of evaluation ( $F = 5.788$ ,  $p = 0.004$ ), the use of animation proved to be significant, while it was less significant in the phase of motivation.

The results indicate that students use LMS ( $F=9.719$ ,  $p<.001$ ) and digital quizzes ( $F=21.93$ ,  $p<.001$ ) the most when practicing and revising. In the same phase, they tend to use screen sharing options ( $F=4.668$ ,  $p= 0.011$ ) and digital tools intended for cooperation and communication ( $F=5.639$ ,  $p=0.005$ ) less.

As future students at class teacher studies in Osijek, Split and Zagreb have different curriculum and implement public lessons in different study phases, their practice in the use of digital tools is not coordinated if the location of study is considered.

The improvement of the process of teaching students at class teacher studies requires creativity, expertise and skills in developing didactical approach to the use of digital tools. The implementation of digital tools is crucial for the development of students' digital competences, and it encourages the use of technology in research, scientific work and teaching processes. Apart from the mentioned, these programs emphasize the importance of training in this area in order for the students to successfully implement digital tools in teaching (OECD 2023).

The process of transforming educational systems with the help of information and communication technology (ICT) requires teachers to have specific knowledge needed to efficiently deal with the challenges in the field of ICT use in teaching (Selwyn, 2012).

## **Conclusion**

Digital tools provide teachers with the possibility to create teaching materials focusing on the students, with the tendency of engaging them into interaction.

The technology continues to play a key role in providing education beyond classical classrooms. Digital learning encourages creativity and gives students a feeling of success, encouraging them to continue learning by thinking further than traditional methods. The use of digital tools enables simple access to information. It enables the information to be preserved; it improves storage and presentation, making the education process more interactive.

In the conclusion of the research on the use of digital tools among students at teacher studies, within the lessons preparation and implementation phase, the importance of continuous



research and adjustment of the teaching practice in accordance with the technology advancements is especially emphasized. The results of the research indicate different forms of using digital tools among student population in different cities. This implies the need for the support and education of the students as regards to the application of digital tools in the educational process. Furthermore, the research emphasizes the importance of ensuring professional training for teachers, in order to encourage efficient implementation of digital tools. By continuously promoting technological tools, one can advance the process of education and ensure its adjustment to the needs of the students and society.

YouTube is especially emphasized as the most frequently used digital tool, which is also confirmed by a global trend. The implementation of YouTube and similar platforms into teaching process may be a beneficial strategy used in order to improve teaching and learning process. Apart from the mentioned, it is emphasized that the students at teaching studies prefer certain digital tools, depending on the phase of public lessons implementation. In the practice and revision phase, digital quizzes and LMS are the most frequently used, while animation is used in the phase of processing and acquiring new teaching content.

Considering different curriculums and years of study, the practice of using digital tools varies among students at teacher studies in different cities. The improvement of the teaching process requires adjustment and development of digital competences among students and their training for efficient implementation of digital tools in teaching.

The conclusions indicate the need for further research and investments into the development of digital competencies in order to create inclusive and advance educational environment, encouraging active learning and personal development of all participants in the educational process.

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## The Transformative Role of Technology in STEM Education

Dumbraveanu Roza

Ion Creanga State Pedagogical University

### Abstract

In the present educational landscape, the integration of Science, Technology, Engineering, and Mathematics (STEM) has emerged as a holistic approach to preparing students for the challenges of the future. Technology is one of the key elements of STEM that helps students learn and develop the skills they need to succeed in the twenty-first century. This paper explores the multifaceted role of technology in STEM education, emphasizing its usefulness in fostering creativity, enhancing knowledge acquisition, addressing practical issues, and developing students' competences.

The research goal is to investigate and analyse the impact of technology integration on STEM education outcomes, with a focus on how it might improve learning experiences and strengthen multidisciplinary links within this synergy. The research aims to demonstrate the relationship between the technology component and the other components of the STEM acronym, as well as to explain its motivating value in students' interest in learning.

The research process is based on gathering and synthesizing relevant scholarly sources to gain insights into current theoretical frameworks and practices. The methodology involves qualitative approaches, data collection from observations and interviews, analysis of STEM practices found in Moldovan educational contexts, and interpretation of the results. The paper discusses some of the challenges associated with implementing STEM education in practice as well as the implications of the findings for technology use and its significance in STEM education. A summary of the research findings is provided, taking into account potential implications for theory and practice.

*Keywords:* technology, interdisciplinarity, technology-enhanced learning, STEM education.

### Introduction

Technology has evolved into a basic tool in the last several decades that has shaped the educational environment by altering traditional pedagogical approaches and creating new ways

for inquiry and learning. Within this dynamic context, the integration of technology into STEM (Science, Technology, Engineering, and Mathematics) education has emerged as a driving force, empowering educators and learners alike to engage with complex concepts and phenomena, encouraging innovation, and developing 21st-century competences. STEM education represents a holistic approach to learning, bridging disciplinary boundaries by fostering critical thinking and problem-solving (Kelley & Knowles, 2016). At its core, it seeks to equip students with the knowledge, skills, and mindset necessary to thrive in an increasingly interconnected world driven by innovation and technological advancement. In this context, technology constitutes both a catalyst and a medium through which students can explore, experiment, and collaborate in their educational route (Westerlin & Vogt, 2022).

This paper endeavours to investigate the transformative role of technology in STEM education, examining its impact on teaching practices. The essence of the STEM concept is to highlight the role of each component, to find connections between them, and to motivate students to engage in studying each discipline. Moreover, STEM education is intended to encourage integrated teaching of the four domains, as real-world phenomena and problems represent holistic entities that need multidisciplinary, interdisciplinary, and transdisciplinary approaches for investigation (Takeuchi et al., 2020).

The aim of the paper is to reveal the ways in which technology enhances the learning experience and promotes interest in studying science disciplines. Also, the paper seeks to emphasize the importance of mindful integration and pedagogical innovations in leveraging technology effectively within the STEM framework, to provide insights for teachers to harness the potential of technology in empowering students to become critical thinkers, problem solvers, and lifelong learners.

Qualitative research methods are used to collect data and develop a thorough understanding of the function of technology in STEM education. It includes an analysis of scholarly publications chosen via the network Researchgate, the open repository Academia.edu, and the Google Scholar search engine to provide a baseline of current knowledge in the topic. A logical framework that directs the examination of the gathered data is created by synthesizing the major themes about the use of technology in STEM education. This synthesis guarantees that the study is based on up-to-date theoretical and empirical understanding. Observations, interviews, and analyses of publicly accessible STEM practices in Moldovan schools are used to compile empirical evidence.

## Reasons for STEM education

STEM education is given high priority by successful countries, as it is considered that its effective use is vital to national prosperity and international standing. STEM disciplines are at the heart of economic growth, because by equipping individuals with skills in these areas, societies can create new technologies, industries, and job opportunities (White & Shakibnia, 2019).

Policy documents and research articles mentioned the main reasons for promoting the STEM approach to education as follows (Freeman et al., 2019).

- **Global Competitiveness.** Countries with strong STEM education systems tend to be more competitive. They can progress in areas like technology, research, and development, giving them a strategic advantage in the global economy.
- **Technological Advancement.** STEM education fuels technological progress, leading to improvements in fields such as healthcare, communication, transportation, and energy. It's crucial for finding solutions to global challenges like climate change, disease prevention, and resource management.
- **Career Opportunities.** STEM education opens up diverse career opportunities across various industries, including engineering, computer science, biotechnology, healthcare, and finance. These fields often offer high-paying jobs and opportunities for career growth.
- **Future Workforce Needs.** As technology advances rapidly, there is a growing demand for workers with STEM skills. STEM education prepares individuals to meet the needs of the future workforce and adapt to evolving economies.
- **Cross-disciplinary Collaboration.** STEM education encourages collaboration across different disciplines. It brings together experts with diverse backgrounds to tackle multifaceted real problems, developing new and innovative solutions.

All of these compelling and enticing arguments ensure a strong basis for advocating STEM promotion as a way to satisfy society expectations and provide motivation for skilled professionals. However, there are other, equally compelling arguments in support of STEM in schools, including the fact that the knowledge children acquire in formal education is essential for real-world situations. Comprehending the sciences, mathematics, and technology has become increasingly important in our contemporary environment, as technology permeates every area of human existence. The daily lives of humans are supported by these disciplines, which extend from the food they consume to the cellphones they use.

Science provides a prism through which people can understand nature. Students learn about the underlying ideas forming the living environment through courses in physics, chemistry, and biology. In today's world, technology is an essential part of any scientific study. For example, technology makes it possible to visualize intricate scientific ideas that would otherwise be challenging to understand. Students can witness scientific phenomena in action through interactive simulations and virtual experiments, which improves their comprehension of the actual world. Maintaining one's own health and welfare requires a solid understanding of the biological sciences. When people understand human anatomy, physiology, and nutrition, they are better able to adopt healthy lifestyles and make choices that promote wellbeing. Individuals who understand the basics of immunization, hygiene, and disease transmission can protect both themselves and other people from illness. Furthermore, advances in cutting-edge medical research have led to the creation of life-saving treatments that would not have been possible without a strong foundation in advanced science and technology.

STEM-savvy individuals are better equipped to identify potential risks and implement the appropriate safety precautions to prevent accidents and injuries. A basic understanding of science and engineering can guarantee safety when engaging in routine activities such as driving, housekeeping, and cooking.

Sustainable behaviours and an awareness of environmental challenges are encouraged by STEM education. Complex issues like pollution, deforestation, habitat destruction, and climate change require engineering, science, and technology advancements in addition to environmental awareness. Science gives communities the power to slow down environmental degradation and protect natural resources for future generations by teaching people about ecological processes, conservation initiatives, and renewable energy sources.

STEM education cultivates critical thinking and problem-solving skills for working out everyday challenges and societal needs. Students familiar with scientific inquiry are able to assess ideas, examine data, and draw logical conclusions when faced with real-world challenges. Critical thinking skills help everyone make wise judgments, whether they are analysing food labels for nutritional value or fixing a broken appliance. People who have a STEM education are better able to comprehend the world, solve problems, maintain their health, interact with technology, and safeguard the environment. Consequently, STEM education is essential for everyone's well-being and not just a topic of academic interest.

## Technology in STEM education

In the 21st century, the integration of technology into education has become increasingly essential, particularly in the fields of science, engineering, and mathematics. It is considered that technology is a catalyst for innovation and transformation in STEM education, revolutionizing the way students learn, engage with concepts, and prepare for future careers (Triplett, 2023). The concept of technology encompasses a broad and complex range of tools and processes that involve the application of scientific knowledge for practical purposes. Technology is not limited to electronic devices or machines; it includes any method, system, or set of tools used to solve problems or achieve specific objectives. According to Britannica<sup>1</sup>, “technology is the application of scientific knowledge to the practical aims of human life and to the change and manipulation of the human environment”. Technology is an ever-evolving collection of interconnected tools, processes, and systems that, like societal needs, are always changing. It transforms human activities, behaviours, and environments, affecting how people interact with the outside world and with each other.

Technology can be considered both means (instruments) and ends (Agar, 2020). In its role as a means, technology serves as a tool that facilitates accomplishing various tasks, such as communication, transportation, manufacturing, healthcare, research, and education. Technology is a catalyst for progress and innovation, empowering knowledgeable individuals and organizations to improve efficiency, enhance productivity, explore new possibilities, and discover new things. It enables the development of new products, services, and systems that drive economic growth and societal advancement. At the same time, technology can also be considered an end in itself, representing the culmination of human creativity, ingenuity, and intellectual pursuit. Technological advancements are often pursued for their intrinsic value, driven by curiosity, exploration, and the desire to extend the boundaries of knowledge and achievements. As an end, technology shapes the way people interact with each other, access information, express themselves, and experience the world around them. The interpretation of technology as an interplay of means and ends is not merely one of cause and effect but of the relationship between technology and scientific knowledge. Technology serves both as the vehicle for scientific advancement and as the ultimate goal of scientific inquiry; they are intertwined in an ongoing process of discovery and innovation.

When it comes to the use of technology in education, especially STEM education, these broad arguments about technology need to be made more specific. The T in STEM is not well

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<sup>1</sup> <https://www.britannica.com/technology/technology>



defined, and it is frequently the responsibility of STEM teachers to comprehend and define the role of technology in their classes (Daugherty, 2009).

Ellis et al. (2020) conducted a literature review and identified four perspectives (points of view) on the use of technology in STEM, drawing on the works of Honey et al. (2014) and Sivaraj et al. (2019).

1. Technology in STEM education is viewed as the product of engineering, given its historical connection to vocational education.
2. Technology in STEM education is considered technology that is used to enhance teaching, learning, and assessment.
3. Technology in STEM education is defined as the tool used by practitioners of science, mathematics, and engineering.
4. Technology in STEM education is regarded as a tool for coding or computational thinking, which can complement mathematical and engineering thinking.

Certain teachers and researchers may pursue and implement one or another perspective and their opinions reflect the experience they have accumulated in the educational context in which they work; therefore, each perspective has its own scope. The relevance of the mentioned viewpoints to the role that technology plays within STEM education should be analysed concerning the reasons for implementing STEM education. As the result of reviewing the four perspectives and their associated examples of classroom enactment, Ellis et al. (2020) came to the conclusion that “while each of the four perspectives has the potential to promote and advance science and STEM content learning and instructional goals, this relationship is most explicit in perspective 3, making it a particularly useful definition of technology for science and STEM educators”. In other words, the role of technology as the most productive with respect to STEM education, curricular and instructional goals in STEM is that of the tool used by practitioners of science, mathematics, and engineering. These authors provided detailed comparisons of perspective 3 to each of the other perspectives, identified the advantages and disadvantages of each perspective for STEM educators, and showed that while viewpoints 1, 2, and 4 have their rights to be integrated in a STEM classroom, perspective 3 has the greatest potential for positively impacting science and STEM learning and is in many ways compatible with these other perspectives.

**A comparison between viewpoints 1 and 3.** Perspective 1 (technology as vocational education, industrial arts, or the product of engineering) renders the T in STEM as an end; but it does not describe the role of technology in the process of learning. “Perspective 1 provides an accurate representation of the connection between engineering and technology: Engineers

design and develop technologies in the form of a new product or process. However, reducing technology to the output of engineering is limiting for teacher educators working toward improving science teachers' understanding and implementation of STEM content" (Ellis et al., 2020).

From this viewpoint, the emphasis is on producing a product (i.e., the technology) through the iterative design process. The easiest way to characterize the activities that fall under this STEM category is as tinkering. These kind of exercises are commonly employed in STEM projects for children, where the end product (building a house model, for instance) is the primary focus rather than the science knowledge learned. But they do not simply tinker; they apply their knowledge of science and math to develop solutions to a problem. This perspective of STEM education can only be accepted as a legitimate teaching approach if there are "strong and explicit connections to the curricula of mathematics and science" (Sheffield et al., 2015). It is imperative to concentrate on how these practices and activities are really applied in an integrated STEM approach, as described in Perspective 3, where students are engaged in scientific practices of sense-making about what they are doing.

Teachers must be made aware of this distinction, as "Perspective 1 is pervasive in schools and curricula that teachers are likely to encounter. All teachers need to learn about the limitations of this approach and develop a full understanding of the varying perspectives of the T in STEM" (Ellis et al., 2020).

**A comparison between viewpoints 2 and 3.** The main differences between these two perspectives – technology as educational technology and technology as tools and practices used by science, mathematics, and engineering practitioners – lie in the teachers' and researchers' opinions about what to consider as an object to which the technology is applied.

Early in the twenty-first century, technological advancements mainly pertaining to Internet-connected devices, online resources, and communication tools led to a heightened awareness of the technologies themselves as well as their potential to improve education. As a result, a new academic area named the pedagogical integration of technology into an educational context emerged (Koehler, 2013). It highlights how crucial it is to take into account how technology affects teaching and learning as well as how to use it to engage students, encourage critical thinking, and foster communication. An essential question is when and how teachers should develop skills in technology-supported pedagogy while taking into account the subject given and the student's grade level.

Many technology initiatives nowadays are intended to support multiple subject disciplines and, therefore, focus on general pedagogical aspects over content-specific

applications. This was made clear during the pandemic, when teachers of different disciplines were trained via online courses and webinars to study diverse tools, without much didactics and without being aware of the degree of usefulness of those digital technologies for their special cases. Of course, generic applications, such as word processing software or presentations, are universally applicable across a range of topic areas, regardless the subject content, but this is not the case for STEM disciplines. Instead, technology should be introduced in the context STEM teaching as a means to the end of supporting meaningful learning of connected disciplines. “This approach is more closely aligned with perspective 3, where science teachers consider the tools and technologies that are not only representative of the work of scientists and other STEM professionals, but directly support understanding of the science content” (Ellis et al., 2020). Thus, viewpoints 2 and 3 are not mutually exclusive; their distinction is in knowing which technologies to use, how to use them, and when.

**A comparison between viewpoints 4 and 3.** Digital technology is an important part of technology in the 21st century, and computational thinking is at the heart of it. At its core, computational thinking embodies a mindset characterized by abstraction, algorithmic design, and problem decomposition. Unlike the conventional perception that associates computing solely with coding, computational thinking transcends traditional boundaries, encompassing a holistic approach to problem-solving applicable across diverse domains. The computational thinking in STEM education is a cornerstone for fostering interdisciplinarity; it provides a structured approach to problem-solving, which is essential across all STEM fields.

There can be a number of difficulties in helping students develop computational thinking skills and incorporating it into STEM education. Many teachers, even those that teach informatics in schools, lack sufficient training in computational thinking concepts and how to effectively teach them. Integrating computational thinking into existing curricula in many countries is a challenge, as developing new curricular materials or modifying existing ones may require significant time and resources, including professional development for teachers.

Developing students' computational thinking skills and incorporating it into STEM education can present a number of challenges, including: teachers who lack computational thinking abilities (even those who teach informatics); curricula that are difficult to incorporate because it takes a lot of time and money to create new materials or modify ones that already exist; and teachers who do not receive enough professional development. School administrators, policymakers, and other stakeholders must continue to support long-term efforts to include computational thinking into STEM curricula. Despite these challenges, current

practices show that there are interesting examples of the integration of computational thinking in promoting STEM education.

### **Teachers' readiness to implement technology into STEM education**

The readiness of teachers to implement technology into STEM education across Europe varies depending on factors such as national policies, educational systems, professional development opportunities, and cultural attitudes towards STEM (Marginson, 2013). While some European countries have made great progress in advancing STEM education and assisting with teachers' preparation, others might encounter difficulties in this area. This section is devoted to key factors and challenges that influence teachers' readiness to implement technology into STEM school education in Moldova. Though they are explained in terms of the current practice in this country, they are also believed to be typical in other countries.

**Curriculum and policy support.** This dimension implies the existence of mechanisms that provide a framework for teachers to effectively leverage technology to enhance STEM teaching and learning experiences, ensuring that they have the necessary guidance, resources, and incentives to integrate technology in ways that contribute to student engagement in studies, the solving of real-world problems, and the development of critical thinking skills.

**Technological literacy.** Teachers' proficiency in using technology is foundational to their readiness to integrate it into education in general and in STEM, in particular. Technology in a broad sense encompasses many categories, such as biotechnology, nanotechnology, renewable energy technology, transportation technology, medical technology, environmental technology, manufacturing technology, and information and communication technology (ICT).

**Pedagogical technological competence.** Effective technology integration requires digital skills that complement contemporary instructional strategies. To accomplish the intended learning outcomes in STEM disciplines, teachers must be able to use technology to facilitate inquiry-based learning, problem-solving, and active learning.

**Professional development.** Continuous professional development plays a crucial role in enhancing teachers' readiness to integrate technology into STEM education. Targeted training programs and workshops can help teachers stay updated on emerging technologies and develop innovative teaching strategies.

**Access to resources.** Adequate access to technological resources is essential for teachers to enrich their teaching and learning practices. Limited access can impede teachers' ambition and ability to incorporate technology into education.

**Supportive environment.** A school culture that values innovation fosters teachers' readiness to experiment with technology and STEM in the classroom. Administrative support, access to technical assistance, and opportunities for collaboration with colleagues can significantly influence teachers' confidence in adopting new technologies.

The concept of STEM is not new as a teaching strategy; some experienced teachers have employed this approach in their practice for decades, but they did not name it as such. In recent years, the term has appeared more often in the pedagogical literature in Moldova. It was promoted through projects supported financially by the United States Agency for International Development (USAID) starting in 2016, and then it was included in the school curricula approved in 2019. The way the STEM concept is presented in the policy documents causes a big challenge for teachers. There is no specific section in the curriculum that describes the STEM concept; its necessity is not rigorously argued, and clear implementation objectives are not stated. The term STEM appears among teaching strategies in the curriculum of some disciplines as one that promotes interdisciplinarity and transdisciplinarity. School teachers are advised to implement STEM activities in lesson plans or as short projects, but it is just a recommendation with no guidelines for implementation or for the role of technology within this approach. The curricula for disciplines like physics, chemistry, biology, and mathematics suggest optional titles for STEM projects during the semester, with no time allocated for realization.

Projects are carried out during classroom and tutoring hours, as well as independent student work. The students present the results usually at the end of the semester, using ICT tools (presentations, portfolios, infographics, demos of models, and other learning objects). These results are occasionally evaluated with grades and sometimes serve as a formative evaluation.

Technology integration in the classroom is a complex issue that needs increasing teacher workloads: first because the term implies a rich spectrum of categories and requires special knowledge to manipulate it; second because no discipline exists in initial teacher education to develop technology literacy; third because technology integration in STEM education is much more than its incorporation in a single discipline. This paper presents two cases that illustrate two practices: 1. the experience that teachers showed in their regular classroom activities; 2. the outcomes of specially formed student and teacher teams trained in project work and computational thinking for competition participation.

Teachers who have participated in national competitions make up the sample in the first case. As part of their competition tasks, they submitted lesson plans and student-made projects to show the STEM approach in action. For this investigation, the STEM artefacts from roughly

sixty teachers in the academic year 2023–2024 were looked at. The bulk of the technology employed by the teachers was associated with ICT, and the extent to which it was integrated varied according to the projects' themes, the teachers' digital literacy, and their technological pedagogy.

The adoption of general-purpose ICT applications was a common feature of almost all projects, which makes sense considering how urgent it was to deploy ICT in response to the COVID-19 epidemic. Schools struggled to make the transition to blended or distance learning, forcing teachers to learn how to use various digital tools and adapt to remote teaching styles. They started utilizing ICT as a tool deliver instruction in real time, and to enrich teaching, learning, and assessment with digital resources in order to motivate students. This development highlighted the critical role that technology plays in education.

This case is an example of perspective 2, in which ICT has the role to enhance teaching and learning. Teachers used web interactive technologies, educational apps, and digital resources to create engaging lessons that went beyond traditional boundaries. Students' curiosity was piqued by interactive tests and group projects that promoted active learning. Concerns about students' and teachers' digital literacy also surfaced at the same time, underscoring the necessity of thorough ICT assistance and training. Bridging the digital divide asked for collaborative efforts from policymakers, teachers, and technology providers to ensure equitable access to digital resources and opportunities for all learners. In 2021, the Ministry of Education and Research, in partnership with Chisinau City Hall and a series of private companies, created two educational platforms – *Online Education*<sup>2</sup> and *Interactive Online Education*<sup>3</sup> – through which a large number of school teachers were trained in the use of digital technologies. The mentioned platforms host a digital library containing over 8,000 recorded short video lessons and other digital resources, grouped by classes and subjects. The second platform offers an online application designed for elaborating interactive exercises and quizzes for formative and summative assessment. Some universities involved in initial teacher training also offer professional teacher development courses in using ICT tools. These courses develop mostly the teachers' digital skills in using generic applications, like content management and delivery (e.g., Google Classroom, Google Meet); communication tools (Viber, WhatsApp, email); tools for storing and sharing digital content (Google Drive); web applications for

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<sup>2</sup> <http://www.educatieonline.md/>

<sup>3</sup> <https://educatieinteractiva.md/>

creating exercises, tests, and quizzes (Socrative, Kahoot!, LearningApps); presentation apps (Canva, StoryJumper), etc.

As a consequence, the trained teachers applied all these tools in a variety of school disciplines, regardless of the subjects; their implementation can be interpreted as educational technology to enhance learning, i.e., as the perspective 2. The majority of the examined STEM projects could be categorized under the same umbrella as they primarily used digital resources and apps for general purposes. While the use of these tools can be viewed as a benefit, it is still an example of general pedagogy-oriented technology, also called technological pedagogical knowledge (TPK) (Koehler et al., 2013), that does not directly promote deep learning of particular subject matter.

The second case refers to teams of students and teachers that underwent specialized training in robotics. This represents another edge of technology integration in STEM projects that allows students to program robots and develop computational thinking through practical problem solving. The robotics study program "RoboClub" was launched in the Republic of Moldova in March 2014 as an extracurricular endeavour.

Currently, the initiative is implemented in 270 educational institutions in the country. About eight hundred robotics kits were provided by the development partners, within the Future Technologies Project, funded by USAID, Sweden, and Great Britain, within the National Study Program of Educational Robotics, implemented by the National Center for Digital Innovations in Education "Classroom of the Future" under the direction of the Ministry of Education and Research.

These tools are accessible to over 40,000 pupils; over 650 educators have received training to instruct robotics in the classroom. Robotics program gave them a hands-on approach to learning that stimulates creativity, problem-solving, and teamwork. The competences developed by students in this program have been shown by project teams who have competed in the national robotics competition FIRST LEGO League Challenge every year since 2015. The competition's primary goal is to foster the growth of transversal abilities like collaboration, critical and strategic thinking, and science and engineering skills.

In 2024, there were 73 teams participating in the ninth season, which brought together 117 coaches and 543 students. The winning team proceeded to the United States Robotics Championship, where they won three prizes: first place in the "Robot Performance" test, mentor award, and finalist award. The robots developed by the competing teams are recognized for their technical performance as well as their programming and operational skills with this prize.

At the competition in Singapore, the victorious team from the eighth edition took home a gold medal.

The application of the fourth perspective in conjunction with the third is demonstrated by this case. Students developed practical skills through robotics education: they learn how to design, build, program, and troubleshoot robots, gaining valuable experience in the process. Students solved complex problems in math, science, engineering, and technology by dissecting them into smaller parts through algorithmic thinking and decomposition. The teams applied integrated STEM knowledge to produce practical solutions to real-world problems.

### **Discussions and conclusions**

The growing interest in STEM education underscores the importance of understanding the role of technology in this interdisciplinary synergy. This paper contributes to the field by clarifying the meaning of technology and exploring its integration into STEM education from various perspectives.

The presented viewpoints on the role of technology in STEM education provide valuable insights for teachers: by understanding and embracing them, teachers can create a dynamic and comprehensive STEM education environment that equips students with the necessary skills and knowledge for the future. Teachers can integrate and combine these viewpoints to tailor their teaching philosophy and create a versatile and robust learning environment, depending on the specific learning outcomes and educational context, ensuring a well-rounded and future-ready STEM education for their students.

It is crucial for teachers to be aware of the diverse viewpoints on the role of technology in STEM education to implement it effectively in the classroom. Whether utilizing technology as a product of engineering, a tool for enhancing teaching and learning, a resource for scientific and mathematical practice, or a means for fostering computational thinking, teachers can create a more engaging and effective learning environment. Teachers should make well-informed judgments that improve the quality of education overall, better equip students for future difficulties, and guarantee that technology plays a significant role in STEM education by being aware of these varied functions.

Teachers should adopt a holistic approach to technology integration in STEM education with the ultimate goal of enhancing teaching and learning practices. Teachers can better meet the varying requirements of their students and create more productive learning environments by taking into account different aspects of technology use. This insight is vital for addressing



future challenges in professional development and pedagogical strategies for integrating technology in STEM education.

The two cases discussed in this paper illustrate distinct outcomes and viewpoints on the use of technology. In one case, teachers in traditional classes had little or no STEM training, whereas in the other, both teachers and students were well-prepared to program robots and solve real-world problems in an interdisciplinary STEM approach. These instances demonstrate how variable the consequences of technology integration may be, depending on the perspective used, the level of teachers' preparedness, and the degree of planning and assistance.

Despite expanded global research on STEM discipline integration, most sample classroom teachers were not familiar with foreign studies. Various factors influence their ability to integrate subjects across disciplines, including subject-specific content knowledge, understanding the learning environment, instructional techniques, and pedagogical technology content knowledge.

Integrating technology into STEM education is a difficult endeavour that demands thorough training and support. Teachers require extensive training to effectively integrate technology into their courses and guarantee that it improves the learning experience. They should incorporate project-based learning into traditional classrooms, with a particular emphasis on technology, in order to implement the STEM approach appropriately. This approach links educational content to real-world applications, making learning more relevant and engaging for students.

This research has several limitations. First, the scope was restricted to observations and interviews within a specific region, Moldova, which may limit the generalizability of the findings to other contexts. Second, the reliance on publicly available data and self-reported information from teachers may introduce biases and affect the accuracy of the results. Lastly, the qualitative nature of the study, while providing in-depth insights, does not allow for quantitative measurement of technology's impact on STEM education outcomes.

Further research should address these limitations by including a broader range of geographical regions and employing mixed-methods approaches that combine qualitative and quantitative data. Additionally, longitudinal studies could provide more comprehensive insights into the long-term effects of technology integration in STEM education. Expanding the scope to include diverse educational settings and populations would also help in understanding the varying impacts of technology on different student groups.

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## **The Use of Digital Resources in the Formative Assessment of Primary education in Romania**

Iuliana Amalia Nica

I. Creanga State Pedagogical University, Moldova

### **Abstract**

The article describes a research that investigated the practices and perspectives of Romanian primary education teachers regarding formative assessment and the use of digital tools in this process. A questionnaire was distributed to teachers, collecting data on their use of formative assessment, familiarity with available digital tools, and their perceptions of technology integration in formative assessment. The final goal of the research was to identify the needs, challenges, and opportunities related to the use of formative assessment and technology in primary education with the aim of improving educational practices and student outcomes.

The results showed that most teachers are aware of the concept of formative assessment and recognize its importance in primary education. However, the use of formative assessment practices in the classroom varies. Interest in integrating digital tools to support this process is also varied, the most frequent motivation being the need to learn how to use ICT tools and educational platforms or limited access to technology. Those who participated in the study stated that they use digital resources sometimes in the formative assessment process, considering that they do not sufficiently support this process. It is, however, to be appreciated that the majority is interested in training activities to improve the skills of using digital resources in the formative assessment process.

The research conclusions highlight the need to improve access to digital resources and the continuous training of teaching staff in improving skills in the use of digital tools in formative assessment.

*Keywords:* formative assessment, primary education, digital resources

### **Introduction**

In recent years, the integration of technology in education has become increasingly prominent, offering new opportunities to enhance teaching and learning processes. The European Framework for the Digital Competence of Educators (Redecker & Punie, 2020)

outlines the essential digital skills educators need to effectively integrate technology into their teaching practices. This framework emphasizes the importance of using digital tools to support personalized learning, engage students, and improve the efficiency of the educational process. The OECD studies on assessment and review in education (Kitchen et al., 2017) further highlight the potential of digital tools in transforming educational practices. These studies suggest that technology can facilitate formative assessment by providing teachers with innovative ways to monitor student progress, deliver timely feedback, and adapt instruction to meet individual student needs. The integration of digital tools into formative assessment practices can create a more interactive and engaging learning environment, ultimately enhancing student outcomes.

A critical review by See et al. (2022) explores the impact of educational technology on learning outcomes, particularly in the context of formative assessment. The review indicates that while technology can support formative assessment by offering diverse and dynamic ways to assess student learning, its effectiveness depends on various factors, including the appropriateness of the tools used, the teacher's proficiency in using these tools, and the context in which they are implemented.

The Digital Education Action Plan by the European Commission (2020) advocates for the integration of digital technologies in education to foster innovation and improve learning experiences. The action plan emphasizes the need for continuous professional development for teachers to effectively use digital tools in formative assessment. This aligns with the findings of the Global Education Monitoring Report (2024), which stresses the importance of equipping educators with the necessary skills and resources to leverage technology in enhancing formative assessment practices.

In the context of Romanian primary education, understanding the current practices and perceptions of teachers regarding formative assessment and the use of digital tools is crucial. The integration of technology in formative assessment practices can offer significant benefits, such as increased student engagement, real-time progress monitoring, and timely feedback (See et al., 2022). However, the challenges identified, such as limited access to technology and the need for ongoing professional development, highlight the necessity for targeted support and training for teachers.

To maximize the potential of technology-enhanced formative assessment in Romanian primary education, it is essential to address these challenges through continuous professional development, provision of adequate technological resources, and the development of

contextually appropriate digital tools. By doing so, teachers can be better equipped to create a more personalized, interactive, and effective learning environment for their students.

In primary education, formative assessment is a continuous and reflective process that allows teachers to better understand their students and provide them with constructive feedback, guiding them on the path of continuous improvement (Karee & Mulvenon; 2009). Formative assessment, defined as a continuous process of gathering information about student progress to guide and adjust their learning (Redecker & Yves 2020), is considered a fundamental practice for improving student performance and the teaching process (Black & William 1998).

At the same time, in the current educational context, technology has become an indispensable resource for the education system, providing significant opportunities for personalizing the learning process, actively involving students and improving the efficiency of the educational process (Kitchen et al. 2017).

In this context, this article aims to explore the practices and perspectives of primary education teachers in Romania regarding formative assessment and the use of digital tools in this process. In an era where technology has an ever-increasing impact on education, it is essential to understand how digital tools are integrated into formative assessment practice and how they are perceived by teachers.

The article aims to highlight not only the current practices, but also to identify the needs, challenges and opportunities for improving the use of formative assessment and technology in Romanian primary education. In the light of this information, recommendations and suggestions can be offered for the development of educational practices and for the training of teachers to respond more effectively to the current demands of the school environment (GLOBAL EDUCATION MONITORING REPORT, 2024). The conducted research aims to investigate the practices and perceptions of primary education teachers in Romania regarding formative assessment and the use of digital tools in this essential educational process. The objectives of the research are:

- analysing formative assessment practices: analysing how primary education teachers in Romania implement and use formative assessment in their daily educational process.

- examining the use of digital tools: establishing the degree of use and familiarity of teachers with the digital tools available for formative assessment and to what extent they are integrated into their educational practice.

- exploring teachers' perceptions: understanding teachers' perspectives and opinions on the benefits, challenges and opportunities associated with the use of formative assessment and technology in primary education.

This article highlights the research results and carries out an analysis of the practices and perceptions of primary education teachers regarding formative assessment and the use of digital tools. By presenting and interpreting these results, the article aims to contribute to a deeper understanding of how formative assessment and technology are integrated into the educational process at the primary level in Romania and to provide clues and suggestions for improving educational practices and student outcomes in this critical stage of education.

### **Research methodology**

The questionnaire was used as a research method through which data were collected from primary education teachers from various schools in Romania. After designing the questionnaire to cover different aspects of formative assessment and the use of digital tools in primary education, it was initially piloted on a small sample of teachers to assess the clarity of the questions and to identify any possible problems or ambiguities in the question forms. The collected data were analysed using descriptive and qualitative analysis methods. Descriptive statistics were employed to determine the percentage of respondents using various formative assessment methods and digital tools, with frequency analysis providing detailed insights into these aspects. Cross-tabulation was used to explore relationships between different variables, such as age categories and comfort levels with ICT tools, allowing for a deeper understanding of the data. For the qualitative aspect of the study, thematic analysis was used to analyse open-ended questions. This method enabled the identification of common themes and patterns in teachers' responses regarding the benefits and challenges of using ICT tools in formative assessment. By employing thematic analysis, the study provided a nuanced understanding of teachers' perceptions and experiences, contributing valuable insights to the overall findings.

After piloting, the completed questionnaire was distributed to teachers from different schools in Romania. Participation in the survey was voluntary, and teachers completed the questionnaire in their free time.

Research sample was formed by a number of 106 primary education teachers from Romania. Regarding the characteristics of those who agreed to answer, it can be specified the following: the surveyed teaching staff belong to the following age categories: 9.4% from the 18-25 years old category, 13.2% from the 25-35 years old category, 38.7% from the 35-45 years old category and 38.7% from the over 45 years old category. The urban zonal belonging of the respondents predominates (72.6%), a fact also explained by the easy access to digital resources in the urban environment.

The teachers' perception towards formative assessment was explored through the questions: "What are the most relevant characteristics for 'formative assessment' in your opinion?", "What are the methods you usually use to carry out formative assessment in the class? "

Analysing the results collected in the questionnaire, it can be noticed that in Romania primary education teachers use various methods in the formative assessment process in the classroom. Thus, observing the students' behaviour and participation during the lesson is the most used method, being selected by 85.8% of the respondents. This suggests that those surveyed pay particular attention to the behaviour and active involvement of students in the learning process. Also, questionnaires or quick surveys on paper or online, as well as individual or group discussions with students are frequently used methods, being selected by about half of the respondents, 50.9% and 51.9% respectively. These results indicate a diversity in the approaches used to assess student progress and performance in primary education, reflecting the importance placed on a variety of formative assessment tools and strategies. On the other hand, methods such as concept maps and graphic organizers are used less frequently, with percentages lower than 14.2% and 6.6%, respectively, suggesting that these approaches may be less integrated into current framework practice didactic in primary education.

Regarding the question "Are you familiar with the documents and recommendations of the European Union regarding formative assessment?", most of those who participated in the questionnaire showed a poor knowledge of the documents and recommendations. These results highlight the need to increase awareness and accessibility to the documents and recommendations of the European Union regarding formative assessment among primary education teachers in Romania. It may also be beneficial to provide additional resources and training to encourage the use and implementation of the practices recommended in these documents to support continuous improvement of the formative assessment process in primary schools.

In the second part of the questionnaire, the questions addressed the degree of use of ICT tools in the formative assessment process. Interpreting the results of the questions "To what extent do you feel comfortable using information and communication technologies (ICT) in teaching and assessment activities?" and "How familiar are you with various ICT tools available for the formative assessment of students (such as online platforms, software applications, etc.)?", it was noticed that the majority of teachers in primary education in Romania feel comfortable or very comfortable with the use of information and communication technologies (ICT) in teaching and assessment activities, and a significant percentage are familiar with

various ICT tools available for formative assessment of students. Examples of digital tools used include Socrative, Kahoot, Paint and others, the total of 23 examples. These tools are used to collect feedback from students, assess their knowledge and skills in an interactive and engaging way, and customize the learning process according to each student's individual needs. However, the examples provided dare not convincing enough that all the teachers know how to choose the right tools so that formative assessment has the expected results. It can be said that there are isolated situations in which teachers know how to choose and use digital resources in the formative assessment process. It can be inferred that there is a high degree of training and competence of teachers in the use of technology in the teaching and assessment process, as well as considerable familiarity with ICT tools available for formative assessment of students.

When asked about the use of ICT tools to collect data on individual student progress, approximately 86.9% of respondents indicated that they use these tools either frequently (21.5%) or sometimes (65.4%). There are 11.2% who plan to start using such tools in the future, while a small proportion (1.9%) who do not plan to start using them. Regarding the digital resources most frequently used in the formative assessment process, a variety of options is noted. Digital presentations (63.6%) and online games (59.8%) are among the most used, followed by videos (61.7%) and tests from online platforms (45.8%). Infographics (25.2%) and web pages (37.4%) are used less frequently, but are still present in teachers' strategies for formative assessment.

These results demonstrate that technology is used in the educational practice of primary education teachers in Romania to support formative assessment and monitoring of individual student progress. The use of various digital tools and resources demonstrates the desire of teachers to create an interactive and personalized learning environment that meets the needs and preferences of students. However, what is worrying is the limited ability to provide concrete examples of digital tools, most of which are limited to Kahoot, Paint or Wordwall applications without specifying how they support formative assessment.

From the answers to the questions regarding the benefits brought by ICT tools in the formative assessment process, it can be seen that their contribution to the formative assessment process is appreciated, with the participants recognizing the benefits and advantages they bring in monitoring and improving the progress of students.

Regarding the effectiveness of ICT tools in assessing student progress, the majority of respondents (97.2%) believe that these tools contribute somewhat (64.5%) or even a lot (32.7%) to more effective assessment of student progress. This suggests that in primary education, teachers perceive ICT tools as useful and effective in the formative assessment process.



Regarding the benefits observed in the use of ICT tools in formative assessment, the main aspects highlighted are:

- Greater student engagement through the use of technology, mentioned by 37.4% of respondents. This aspect emphasizes the ability of ICT tools to engage and motivate students in the learning process through interaction and digital experiences.
- The ability to monitor student progress in real time, mentioned by 22.4% of respondents. This indicates the ability of ICT tools to provide teachers with a constant and up-to-date perspective on student progress, allowing prompt and personalized interventions.
- The opportunity to provide faster and more accurate feedback, mentioned by 17.8% of respondents. This aspect highlights the effectiveness and practicality of ICT tools in providing constructive and improvement-oriented feedback, supporting student learning.

Interpreting the results of these questions, it can be said that in Romania primary education teachers face various challenges in using information and communication technologies (ICT) in formative assessment, but are generally open to improving their skills by participating in trainings or courses additional.

The main challenges identified in the use of ICT in formative assessment emerge from the questions at the end of the questionnaire: "What are the main challenges you face in using ICT in formative assessment?", "Are you interested in participating in additional training or courses to improve your skills in using ICT in formative assessment?". The need to learn to use new tools and platforms, mentioned by 43% of respondents, indicates the difficulty and challenges associated with adapting to new and ever-changing technologies needed to effectively implement formative assessment using available ICT tools. Limited access to technology in school or at home for students, mentioned by 36.4% of respondents, reflects concerns about inequalities in access to technology among students, which may affect the effective implementation of ICT-based formative assessment.

There are concerns about the security and privacy of student data, cited by 19.6% of respondents. This highlights concerns about protecting students' personal data in the digital environment and the need to ensure the confidentiality and security of information.

However, the majority of teachers are interested in improving their skills in using ICT in formative assessment, according to the results of the question about attending additional training or courses. Thus, 65.4% of respondents indicated that they are definitely interested in participating in such trainings, while 30.8% indicated that they might be interested. This indicates an increased desire to learn and develop in the area of using technology in the formative assessment process.

## **Discussion**

Formative assessment is an essential aspect in the educational process, providing teachers with valuable information to guide student learning. In the current context of education, technology plays an increasingly important role in supporting this process, offering multiple opportunities for personalizing learning. In the light of this study, which investigated the practices and perceptions of primary education teachers in Romania regarding formative assessment and the use of digital tools in this process, several aspects can be highlighted.

One of the important findings is that most teachers are comfortable using technology in teaching and assessment, but not many are familiar with various ICT tools available for formative assessment of students. There is a need for continuous skills development in this area, as limited access to technology in school or at home for students and the need to learn to use new tools and platforms are among the main challenges identified.

Although teachers appreciate the benefits brought by ICT tools in the formative assessment process, such as increased student engagement, real-time progress monitoring and fast and accurate feedback, there is still a need to strengthen and further develop the use of these tools. This can be achieved by providing appropriate training and support so that teachers can effectively integrate technology into their educational practice and benefit from its full potential. Because formative assessment involves providing detailed feedback, not simple "Correct/Incorrect" and "True/False", teachers in Romania must also use applications/platforms that provide explanations for students' errors. This is an aspect that needs improvement.

Based on the information gathered from the questionnaire, several challenges and needs of the educational system in Romania can be identified:

- exploring in depth how technology can be used to address different student needs and support personalized learning within formative assessment
- investigating the impact of technology use in formative assessment on academic achievement and student motivation for learning
- developing and providing continuous training for teachers in order to effectively use technology in the formative assessment process
- the development and evaluation of new tools and digital resources for formative assessment, adapted to the specific needs of primary education
- researching how technology can be used to address inequalities in access to education and digital resources for students and teachers.

## **Conclusions**

The study analysed the use of technologies in the formative assessment process in primary education, with the majority of teachers stating that they frequently or occasionally use digital tools for this purpose. ICT tools used for formative assessment are limited; online platforms, software applications, educational games and multimedia resources are used, each with its own distinct advantages and characteristics.

A positive perception of the impact of ICT in formative assessment was found, with the majority of respondents indicating that the use of technologies in formative assessment had a positive impact on the learning and teaching process, facilitating quick and accurate feedback, monitoring student progress and their increased involvement in activities for studying.

To maximize the benefits of using ICT in formative assessment, it is essential to provide teachers with access to training and adequate support to learn to use these tools effectively in their educational practice. It is necessary to identify research directions and practical initiatives to develop and continuously improve the use of ICT in formative assessment in primary education, adapting to the changing needs and demands of students and society in general.

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## **The use of Virtual Reality in Learning and Teaching Visual Arts in Grammar School**

Lana Skender and Laura Ivanković

Academy of Arts and Culture in Osijek, University of Osijek, Croatia

### **Abstract**

Over the past ten years, Virtual Reality (VR) has been widely utilized in education across various fields, including visual arts. It allows students to interact, contextualize, and have a more profound experience of artworks. The advantages include students visiting virtual galleries and museums worldwide, exploring sites and architecture in three dimensions, and creating their virtual galleries during the learning process. The research aims to examine students' attitudes toward the impact of virtual reality on understanding the subject matter of Visual Arts. The study determined the extent to which students use different forms of VR outside of class, their opinions on the frequency of using various forms of VR during learning, and the impact of VR usage on teachers' instruction. The research involved 84 students from grammar school programmes in Vukovar and Osijek. Survey results indicate that only 9.5% of students were unfamiliar with VR outside the classroom. Virtual galleries were the most commonly used form of VR content during class, while other forms were less prevalent. Most students believe that using VR content makes teachers' instruction more exciting and showcases their creativity. Additionally, most students feel that using VR content makes learning more engaging, enhances the perception of artistic works, allows for contextualization, encourages creativity, and improves knowledge acquisition. Ultimately, survey results suggest that VR technologies have the potential to enrich the learning experience, and there is interest in increased utilization of such content.

*Keywords:* grammar school, virtual galleries, virtual reality, visual art

### **Introduction**

Today's society is influenced by information technology, which has significantly changed how people teach and learn. These changes have been accompanied by pedagogical transformations, leading us towards immersive methods that foster deeper and interactive

learning. To contribute to a better understanding of the subject matter, teachers and students employ various techniques to make teaching and learning more engaging, and one of these methods is teaching visual arts using virtual reality (VR).

The term *virtual reality* was first used by Damien Broderick (1987) to describe a computer-simulated environment in which user interaction with the environment occurs through sensory devices. He depicted a futuristic setting but did not provide a technical explanation or definition of virtual reality. Following this, contributions can be found in the pioneer of this modern technology, Lanier (1980), who popularized the term in the 1980s and extensively discussed VR's social, ethical, and philosophical implications. Although virtual culture is often attributed to science fiction, Lanier (1980) argues that virtual reality technology was never intended to blur the boundaries between virtuality and reality altogether. Instead, the primary goal was to enable humans to use virtual reality technologies to improve their lives in physical reality. By stimulating human senses, experiences are created through images, thus allowing direct participation in a virtual environment in real time (Lowood, 2023).

VR has great potential as a resource for contextualized, location-based learning. Research by Klippel et al. (2020) on educational experiences based on the design of immersive virtual tours has shown positive results in achieving learning outcomes and has served as preparation for actual visits to field locations. They have opened up great opportunities for virtual tours to create new models of knowledge (Cabero-Almenara et al., 2022). Virtual technology provides students with more engaging and dynamic lessons that surpass traditional teaching methods. Using various applications, virtual experiences encourage students to engage and deepen their understanding of art creatively. Through simulated experiences, students are encouraged to practice their skills in a safe environment (Hussein, 2015). The technology of VR uses computer-generated images that react to human movements, which enables users to interact with virtual spaces and opens doors to various immersive experiences (Steuer et al., 1995).

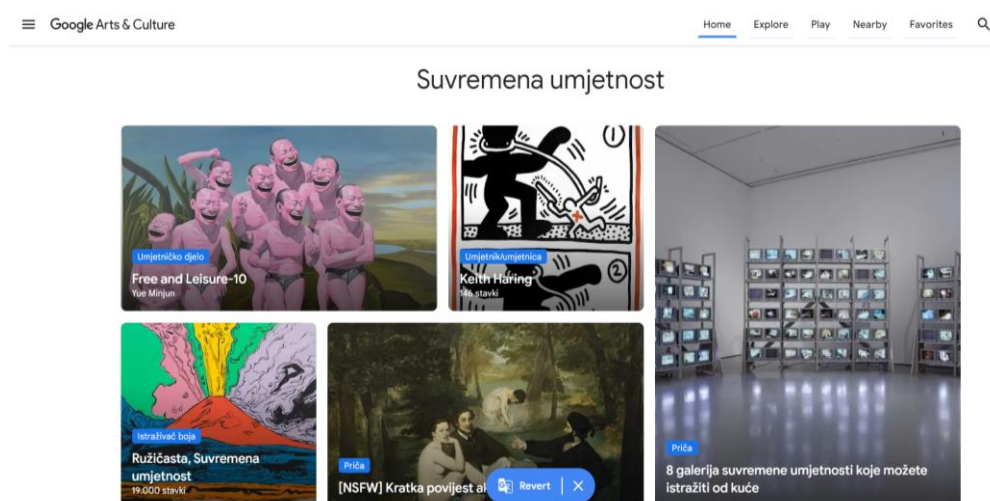
The main advantages of VR are immersive, interactive, and engaging learning experiences. Overall, VR has the potential to transform education by offering innovative ways to engage students, personalize learning experiences, and expand access to high-quality educational content. As technology continues to evolve, its role in education will likely become increasingly prominent, shaping the future of teaching and learning. Integrating VR into modern educational practices provides teachers with a new tool that allows innovative methods to reach more students. VR aims to enhance, motivate, and encourage students to engage in specific learning activities.

Another essential aspect to investigate to understand the role of VR in education is students' attitudes towards this technology. This aspect involves a personal understanding of the technology and the readiness of students to integrate it into the learning process. Prensky (2001) identified 20 years ago that educational systems no longer meet the demands of the new digital generations (digital natives) and there is a generational and technological gap between teachers and students because teachers are digital immigrants. Generation Z, especially Generation Alpha, raised in a digital world, is pivotal for the VR industry (Dimmock, 2019; Mc Crindle, 2020). They embrace new tech eagerly, expecting immersive experiences. VR provides interactive engagement with the digital realm. Their exposure to tech makes them natural innovators shaping VR's future.

Lately, there has been significant interest in scientific research on the application of VR in visual art education. Studies have shown that the quality and quantity of research on VR in visual art education are increasing (González-Zamar & Abad-Segura, 2020). A trend analysis of the scientific articles on the application of VR in visual arts education from 1980 to 2019 found that the interest in VR research in visual arts education has particularly increased during last three years (2017–2019). While only 5.79% of articles on this topic were published in the first 20 years (1980–1999), in the last decade of analysis (2010–2019), 76.08% were published. The theoretical and conceptual foundation of VR in visual arts education was established in the first year of publication, with later contributions focusing on the application of VR in specific situations. The number of articles on research into the application of VR in visual arts education has been growing over the last 40 years (González-Zamar & Abad-Segura, 2020).

VR in visual art education occurs in two ways: the teacher uses it during teaching to expand the contextual approach, and the student uses it to create or use VR for learning. Making and using virtual spaces for teaching about periods, styles, artistic issues, or authors themselves speaks to the educator's creativity and readiness to leverage the advantages of virtual technology in teaching art history or creative skills. Experiential learning through VR excursions aligns with the constructivist approach and practical knowledge of J. Dewey (Covin, 2020).

Virtual galleries and museums are the most popular forms of VR in visual art education because they provide an entirely new experience. They offer the opportunity to explore various exhibition spaces, gather information, and view artworks from different perspectives. Examples include *Google Arts & Culture*, which enables virtual tours of museums such as the Louvre, Guggenheim, and the National Gallery in London. In addition to the possibility of interactive exploration of artefacts in high resolution, thematic virtual exhibitions are also offered (Figure 1).



**Figure 1.** Google Arts and Culture (May 9, 2024). Home [Screenshoot]. <https://artsandculture.google.com/>

In today's digital world, museums must manage their physical and virtual spaces (Katz & Harpen, 2015; Sundars et al., 2015). Virtual galleries and museums offer broad opportunities for teaching art in the classroom. After the COVID-19 pandemic, it has become clear how online art resources can be helpful in teaching. Open access to museum artefacts worldwide does not threaten museum attendance but encourages visitors to come (Verde & Valero, 2021).

Recently, one form of VR capturing the audience's attention is immersive exhibitions. The exhibition *Van Gogh: The Immersive Experience* has become one of the most visited traveling exhibitions (Figure 2). The exhibition aims to present works by the renowned Dutch painter Van Gogh in a new 360-degree digital format, allowing visitors to immerse themselves in art and actively interact with the paintings. Virtual reality glasses enhance the experience, making visitors part of the artistic scene. This exhibition indicates that the application of VR technology in curatorial concepts guarantees attendance and encourages interest in learning about art.





**Figure 2.** *The exhibition Van Gogh: The Immersive Experience, Immersive Van Gogh New York Exhibit, New York's Pier 36, Photo by: Nina Westervelt, <https://www.flickr.com/photos/mtaphotos/51238711449/>*

Helpful in creating VR Galleries is a web-based application, *ArtSteps* that allows students and teachers to create virtual galleries and exhibition spaces for artworks independently. It is a user-friendly tool that can be used via a web browser without additional software. Google Expeditions is a virtual reality platform created for the classroom. It is a tool that allows students to explore various locations, museums, galleries, historical monuments, and more using computer screens or VR headsets. These tools positively impact education by enriching students' experiences through virtual reality, encouraging creativity, collaboration, and a better understanding of art.

Nowadays, various mobile applications for the presentation of cultural heritage can be found, as heritage institutions have recognized the value of developing innovative digital environments. The market primarily has museum guides, VR environments, and location-based applications. The Notre-Dame de Paris application is designed for visitors to the Notre-Dame Cathedral in Paris. The fire that struck the famous Gothic cathedral in 2019 prompted the creation of this mobile application, aiming to preserve the Notre Dame Cathedral in its original form, which it may no longer have in the future. For this reason, the application seeks to bring users closer to the long history of this significant architectural monument and uncover all its historical layers using 3D models and elements of VR. Users can click on specific points to learn the most crucial information about that part of the cathedral, such as the leading portal of the facade or the ambulatory in the interior. The application also includes a list of all

representative parts of the cathedral, including sculptures, rosettes, towers, portals, etc. Additionally, the application describes essential moments in the cathedral's history, from its origins in ancient times to the 19th-century restoration.

Today, one of the most current forms of VR technology are computer games featuring examples of cultural heritage. The *Assassin's Creed* game series transports players back to the time of the Renaissance, the French Revolution, and ancient Egypt, where they participate in battles, encounter historical figures, and explore historical landmarks (Figure 3). In the game, players can explore a total of sixty-six historical locations. Each of these locations serves as a portal providing insights into different periods, categorized into five categories: art and science, beliefs and daily life, life at court, economy, and power.



**Figure 3.** Re-creation of Notre Dame by Ubisoft for its game *Assassin's Creed Unity* (2014). Ubisoft <https://news.ubisoft.com/en-us/article/2Hh4JLkJIGJIMEg0lk3Lfy/supporting-notredame-de-paris>

*Minecraft Education* helps students develop critical spatial competencies. Students explore real-world problems in digital imaginary worlds, fostering a passion for collaboration and play. This approach encourages teamwork and communication skills, making it easier for students to find solutions and develop creativity. They can use *Minecraft* as a platform for collaborating on artistic projects, building virtual worlds, or recreating works of art. The infinite virtual space of *Minecraft* enables students to recreate historical and cultural sites, enhancing their understanding of art history and world cultures. Students can organize virtual art exhibitions and develop digital literacy skills. Integrating *Minecraft* into art education promotes an interdisciplinary approach, connecting art with other subjects such as history, geography, and mathematics.

Through these games, students can expand their knowledge of different cultures and cultivate an interest in exploring the real world. Mobile devices and tablets have a positive impact by facilitating engagement in the educational environment and serving as a motivating tool for students. This research determines how much VR is used in teaching visual art in grammar schools and students' attitudes about using this technology in class.

## **Materials and methods**

Eighty-four students participated in the survey's implementation, of which 39.3% were from Vukovar Grammar School and 60.7% attended First Grammar School Osijek. The participants were students from the 3rd and 4th grades, of which 41.7% were male and 53.6% were female.

The data were processed using descriptive statistics, and interpretation relies on differences between values expressed in percentages. The survey results will only be used for statistical analysis and general conclusions, and the survey is anonymous, so no one can access the respondents' data.

The survey consisted of 20 questions organized into several different groups. The first question about VR allows for multiple answers and investigates which content students use daily. The remaining questions are divided into three groups. The first group of questions determines students' familiarity with VR by examining what VR content (virtual galleries, museums, computer games with art content, augmented reality, 3D models of architecture and sculpture) they have used in class. The second group of questions assesses students' opinions on the impact of VR on teaching, whether it makes teaching more engaging and creative, and whether it assigns tasks in which students create VR content. The third group of questions examines the impact of VR on learning success. They express opinions on whether VR makes learning enjoyable, deepens the perception and experience of artworks, enables them to influence their learning process, and stimulates their creativity.

The first question allowed for multiple-choice answers. Responses to the other questions were graded on a Likert scale model with five levels (1 - strongly disagree, 2 - disagree, 3 - neither agree nor disagree, 4 - agree, 5 - strongly agree).

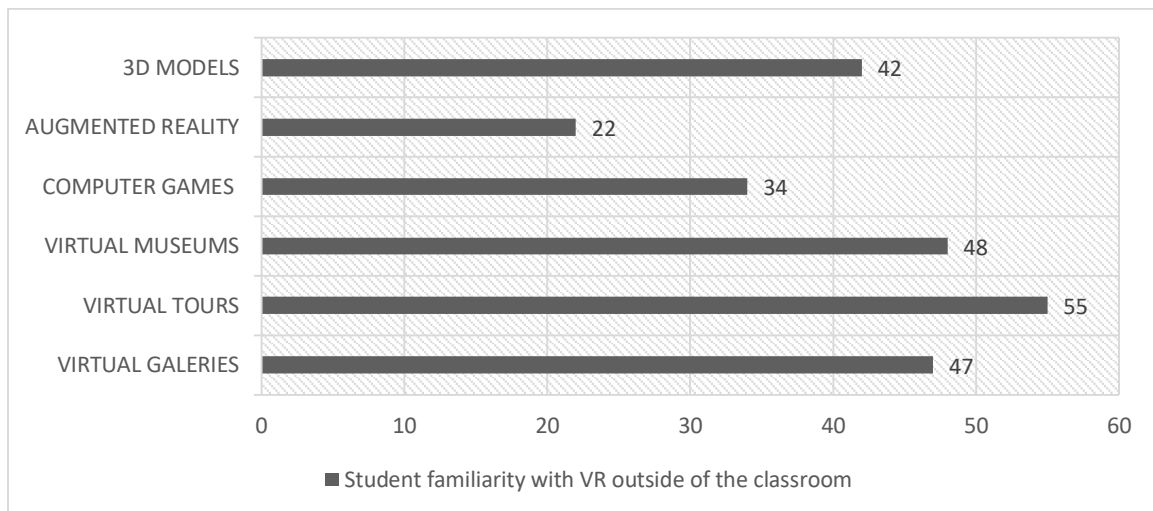
### *Research questions*

The research aims to examine students' attitudes about the impact of virtual reality on understanding the subject matter of Visual Arts. According to this goal, three research questions were raised:

1. What forms of virtual reality are students familiar with?
2. What is the student's opinion on the impact of virtual reality on teachers' instructions?
3. What is the student's attitude to the impact of virtual reality on learning effectiveness?

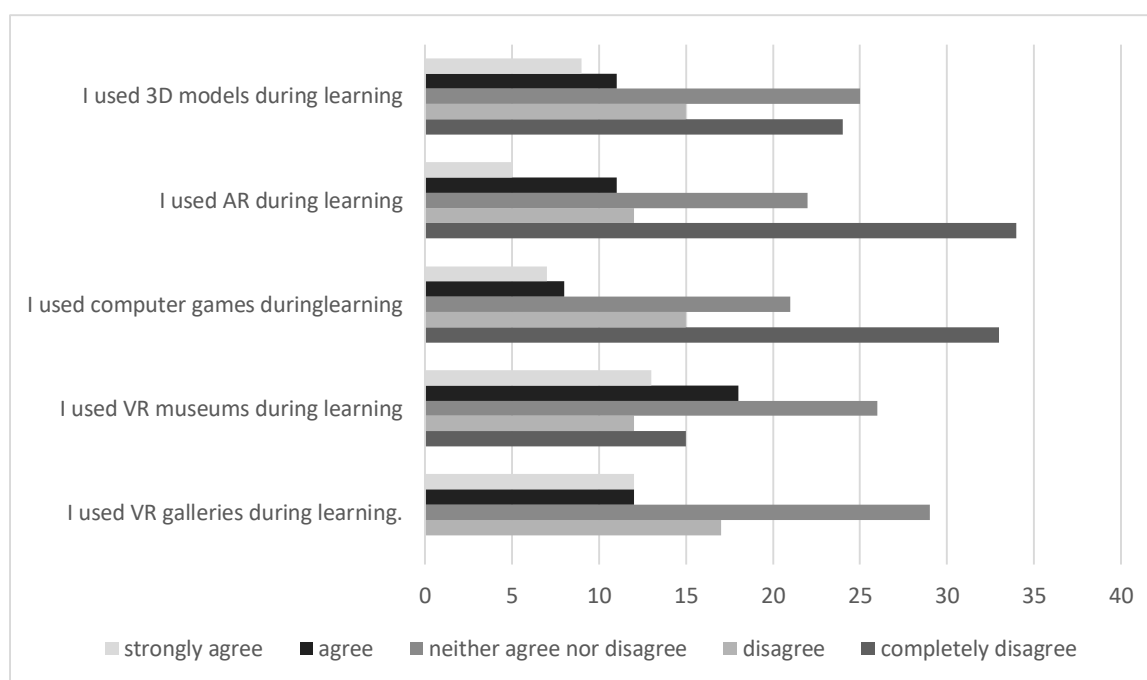
## Results

In the first part of the research, students were asked about their familiarity with various forms of virtual reality outside of school, with the option to choose multiple answers (Figure 4). The analysis of the results shows that students mostly used VR (65.5%) in everyday life, but 9.5% were unfamiliar with it. These results provide insight into students' diverse experiences with virtual reality outside the school environment. The most used are virtual museums (57.1%) and virtual galleries (56%), then 3D models of architecture and sculpture (50%), and computer games with art examples (40.5%).



**Figure 4.** Student familiarity with VR outside of the classroom

In the following questions, students expressed their opinion on the frequency of use of different forms of VR during learning in the classroom according to the Likert scale (1 - strongly disagree, 2 - disagree, 3 - neither agree nor disagree, 4 - agree, 5 - strongly agree) (Figure 5). The majority of students (36.9%) think that they did not use virtual galleries for learning, but on the other hand, 28.6% of students think they did.

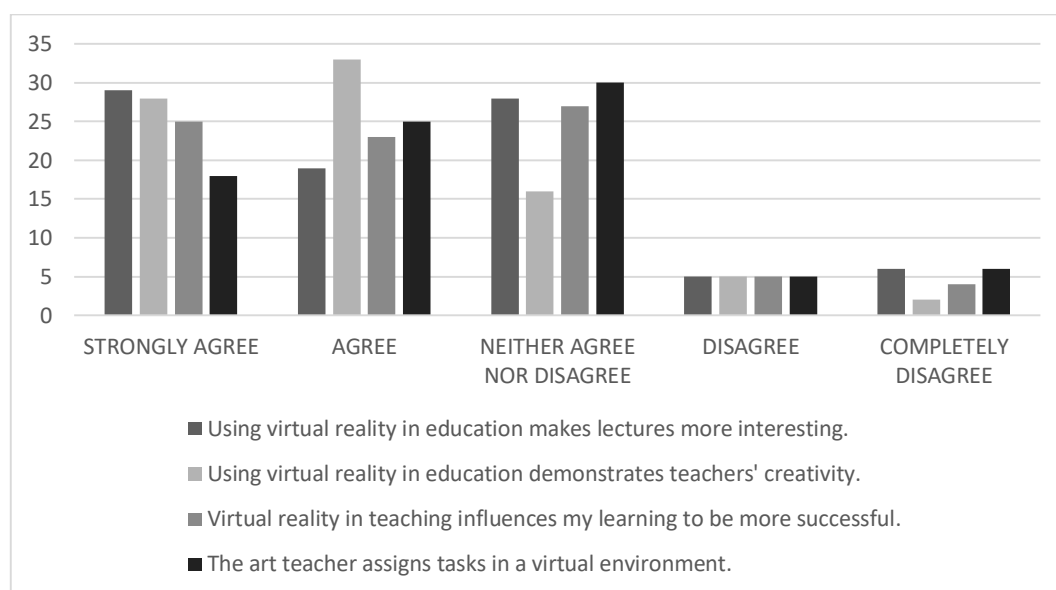


**Figure 5.** The frequency of using VR elements during learning

Regarding using virtual museums and galleries during classes, 65.5% of students expressed a positive attitude. On the other hand, 22.2% of students expressed disagreement with using virtual museums for learning visual art. Many students (57.2%) think they did not use computer games with art examples. On the contrary, 17.8% of students expressed a positive attitude towards using computer games with artistic content for educational purposes. Most students (54.9%) are unfamiliar with learning visual arts through augmented reality. Additionally, 18.6% of students think positively regarding augmented reality in learning visual arts. These responses indicate the existence of a smaller group of students who are better acquainted with this concept. Although the first question revealed that half of the students are familiar with 3D models of architecture and sculpture, further inquiry was made into the actual application of this technique in learning. The results showed that almost half of the students (46.5%) disagreed with the statement that they had used 3D models during learning.

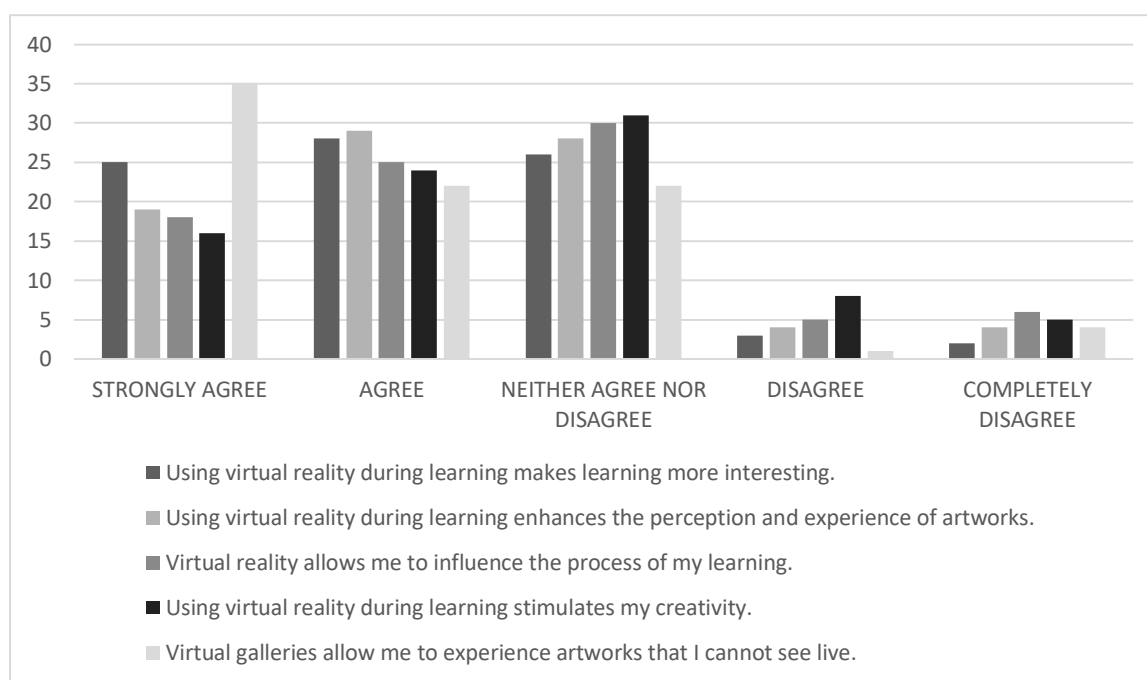
In the continuation of the research, student's attitudes toward the impact of virtual reality on teacher instruction were examined (Figure 6). These results indicate that a significant number of students (57.1%) recognize the positive impact of virtual reality on teachers' instructions and agree that virtual reality makes learning art more engaging. Analysing students' attitudes regarding the effects of using virtual reality on teachers' creativity, most students (72.6%) think positively about that. Most students (57.2%) believe that virtual reality affects learning in a way that it is be more successful. When teachers ask about assigning tasks in a

virtual environment, it is observed that half of the students (51.25%) claim that teachers assign tasks. 13.1% of students disagreed with the statement that teachers assign tasks.



**Figure 6.** Students' attitudes toward the impact of virtual reality on teacher instruction

When examining students' attitudes towards the impact of using virtual reality on learning effectiveness, it is noticed that more than half of the students (63.1%) recognize the positive influence of using virtual reality on their interest in learning, and 31% of students don't have an opinion about that (Figure 7). Just over half of the students, 51.2%, responded that virtual reality enables them to influence the learning process. The results confirm that most students see the potential of virtual reality to enhance their education. In analysing responses to whether the use of virtual reality during learning promotes creativity, 47.6% have a positive attitude regarding the promotion of creativity through the use of virtual reality during learning. 67.9% of students think that virtual reality allows them to explore artworks not available in the real world. These results reveal that most students perceive virtual galleries as a valuable tool for exploring and getting acquainted with artworks they otherwise would not be able to see in the real world.



*Figure 7. Students' attitudes toward the impact of virtual reality on learning effectiveness*

## Discussion

New digital tools such as AR and VR must become part of the 21st-century curriculum because immersive environments are conducive to complex problem-solving, critical thinking, creativity, collaboration, and digital literacy (Covin, 2020; Stavroulia et al., 2017). Using virtual environments in the classroom enables innovative art education because it facilitates new teaching and learning possibilities (Verde & Valero, 2021).

The results show that most students (65.5%) had experiences using VR content in their daily lives (Holly et al., 2021). They most commonly used virtual galleries and museums from specialized websites dedicated to cultural heritage. Most experienced art through 3D architecture and sculpture models, while slightly fewer (40.5%) played games where cultural artistic heritage was represented as the setting or area of activity.

Despite students' everyday experiences with VR indicating that it has become a familiar technology to them, the potential of VR content in the teaching process remains underutilized. Most students think they have yet to use various forms of VR during the classes. Over half of the students said they had not used games with cultural heritage or augmented reality during visual arts classes. Only the use of VR galleries and museums shows potential in teaching visual arts because 57.1% of students use them daily, while 65.5% use them in class.

Students recognized the positive impact of VR on teaching and learning visual arts more than teachers. Most students believe that VR positively affects the quality of teaching because

they mostly agree with all statements. They recognized that VR makes teaching more engaging and exciting, demonstrates the creative abilities of teachers, and makes learning more successful, whether used as a teaching tool or created by students during learning. This is an expected result since, at the beginning of the research, they showed that they actively use VR outside of class and for purposes other than learning.

Presenting educational content using VR technology makes teaching more engaging and appealing, enhancing students' motivation and interest (Stavroulia et al., 2017). More than half of the students (63.1%) have recognized that VR technology positively impacts learning effectiveness and that they can thereby influence the regulation of their learning and develop metacognition. Students enjoy AR/VR learning and track the learning processes, and AR/VR systems help them acquire more precise knowledge (Valmaggia et al., 2016). Most think that VR galleries and museums offer an immersive experience that can partially compensate for the fact that artworks are not experienced live. However, the majority must recognize the creative potential of VR (47.6%).

Students' lives today are permeated with VR experiences they acquire from an early age outside the educational system. In such an environment, they feel natural and motivated to learn. The advantages of VR in teaching art undoubtedly lie in the high quality of the image, which allows us to see the artwork as faithfully as possible to the original. Then, we can construct spaces and 3D environments where we behave as we do in real life and change perspectives by moving around. Spatial contextualization of subjects contributes to cognitive, social, and historical contextualization. The most significant contribution to active learning methods is the ability to use ready-made VR content and create custom VR content.

## **Conclusion**

The use of modern technology, such as VR, in education enhances the student learning process. It generates greater motivation among students, creating a positive working environment that makes classes more dynamic and allows for the development of cognitive styles. A survey presented in this paper, conducted among grammar school students in Vukovar and Osijek, provided insight into their attitudes toward the impact of VR on learning and teaching Visual arts. The survey results indicate that most students see positive effects of VR in education. Students think using VR technology in teaching encourages better observation and experience of artwork, improving the learning process and fostering creativity. A few students disagreed with the statements about the positive effects of VR technology in education. Ultimately, the survey results suggest that VR and AR technologies have the potential to



enhance education and enrich the learning experience of art because the technology partially compensates for the live experience of artworks.

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## Professional development of teachers on the eTwinning digital platform

Dusana Maric Cubra<sup>1</sup> and Maja Brust Nemet<sup>2</sup>

<sup>1</sup>Internationella Engelska Skolan Helsingborg

<sup>2</sup>Faculty of Education, Josip Juraj Strossmayer University of Osijek

### Abstract

The professional development of teachers in today's world of rapid changes and challenges can be continuously achieved through cooperation and partnerships with institutional, local, national and international stakeholders. Interest in helping colleagues, collegiality, extrinsic and intrinsic motivation for improvement, two-way mentoring, proactiveness, decision-making and operational focus on professional focus can lead to a culture that includes continuous learning for all stakeholders in the educational system. eTwinning is a digital platform that brings together teachers and other educational staff and continuously promotes lifelong learning and professional development because it networks teachers with the help of ICT. It is a community that provides teachers with different resources and learning opportunities and promotes the use of ICT in education by involving teachers in online courses, webinars, workshops, projects and conferences. Cooperation among teachers from different European countries contributes to the internationalisation of education and promotes international collaboration, inclusion and receptiveness. The review aims to provide insight into the relevant scientific literature and an overview of research on the importance of professional development of educational staff through various forms of collaboration through the eTwinning digital platform. Studies have shown that it is necessary to encourage cooperation among teachers because it contributes to creating a positive school culture. In addition, digital platforms are helpful, especially eTwinning, since it promotes not only the use of technology and the development of digital competencies, cooperation, reflection, exchange of experiences, innovations, different forms of communication, but also building of friendships and encouragement of creativity and productivity.

*Keywords:* digital competencies, educational staff, professional competencies, reflection, cooperation.

## **Introduction**

Teachers' professional competencies are the skills, dispositions, attitudes and knowledge required to practice teaching effectively (Moreno-Murcia et al., 2015). Teachers should acquire all components of professional competence during their studies and lifelong professional development. The Commission of the European Communities (2008) recommendations highlight the need to develop more complex skills and adaptability, self-regulation, lifelong learning, civil engagement, and activism. The topics that extend through all eight key lifelong learning competencies are as follows: critical thinking, creativity, initiative, problem-solving, risk assessment, decision-making, and constructive management of feelings. The model of action competence is based on the basics of active construction of knowledge, which is interactive and represents a form of asymmetric interaction, dependent on the context, subject, and content being learned. Education for action competence implies developing intrapersonal skills (self-competence) and interpersonal skills (social competence). It is being realized within the framework of the following orientations: orientation to problem-solving, communication, cooperation, effectiveness, self-organization and integrity (Florić-Knežević, 2005). The action competence model is intended to integrate two opposing pedagogical reflections. At the basis of this integrative approach, the goal is for social needs to acquire a characteristic that favours the development of the individual in such a way that it does not alienate them from their personality and for individuals' needs to acquire a characteristic that corresponds to authentic social development (Gojkov, 2012). Regarding all the elements mentioned above that make a teacher a professional, emphasis is placed on teacher education, which should support the teacher's professional development during all phases of his professional career. Therefore, it is necessary to research and improve all key factors for teacher training (Brust Nemet, 2015). Qualitative pedagogy is implemented by teachers who are continuously involved in professional and personal development, who reflect on their practice, cooperate with colleagues and pass on their enthusiasm for lifelong learning. Supervision as a form of support for professionals working in the field of upbringing, education and provision of psycho-socio-pedagogical assistance is one of the ways to protect mental health, improve professional and work competencies and improve the quality of services provided to users (Kusturin, 2007). The teacher's professionalism is also reflected in their responsibility for implementing the requirements set by the competent institutions in a way that is based on the belief that every student can be successful and therefore providing them with the best support for development and learning (Brajković, 2013). Therefore, every teacher needs help in the form of lifelong formal and non-formal training to meet the demands of the modern teacher and

satisfy their needs for success and self-expression (Brust Nemet, 2015). Ljubić Klemše et al. (2012) consider work in projects as a teacher's fundamental competencies that can be continuously developed through cooperation and partnership with institutional, local, national and international stakeholders. Teachers collaborating with the professional development service, the principal and the local community is necessary for the development of the school in a broader sense. Professional development, both personal and at the school level, is only possible through cooperation. Depending on the project's direction, projects can be realized to help the school strengthen and improve various educational components. Cooperation, understanding and acceptance of colleagues are part of social-pedagogical competencies, but they also strongly influence the entire school culture (Brust Nemet, 2015). Pedagogical competencies of teachers in forming an educational partnership with the professional development service, the principal, and the local community can contribute to the development of school culture. Namely, teachers, with the help of their pedagogical competencies, which include interest in helping colleagues, collegiality, extrinsic and intrinsic motivation for improvement, two-way mentoring, proactiveness, decision-making and operational focus on professional focus, can lead to a culture that includes continuous learning for all stakeholders in the educational system (Roby, 2011). The review aims to provide insight into the relevant scientific literature and an overview of research on the importance of professional development of educational staff through various forms of collaboration through the eTwinning digital platform.

### **Cooperation and collaboration of teachers to co-create a professional community**

There are several definitions of teachers' cooperation, collaboration and partnership, which in the Croatian context are often considered synonyms. Teachers' cooperation is working in groups or teams to improve educational processes and outcomes (OECD, 2009). Another definition is that teachers' cooperation is joint group interaction in all activities needed to perform a shared task (Vangrieken et al., 2015). Eschler (2016) defined teacher collaboration as an interdependent relationship in which two or more teachers interact by sharing information and knowledge, planning, and problem-solving. Teacher collaboration occurs when two or more teachers try to solve complex problems together they could not solve on their own (Tzika et al., 2019). Partnership is defined as a relationship resembling a legal partnership and usually involves close cooperation between parties having specified joint rights and responsibilities (Merriam-Webster, 2024). Furthermore, collective work involves more than incidental interactions between co-workers or team members: it integrates workflows within a wider

network or brings together agents to participate in projects or share goals. Teachers' collective work consists of a wide range of interactions involving *curricular structure* - teachers have specific roles within the organisation of the curriculum; *student trajectories* - teachers build on students' prior learning and steer students through the curriculum; *everyday events in school* - teachers respond to the actions and expectations of students and colleagues within the school; *cooperation with other professionals* - teachers collaborate directly with colleagues and other professionals (e.g., health or social workers, student teachers, teacher educators, or researchers); *school organisation* - teachers are involved in formal or informal meetings as part of school life (Grangeat & Gray, 2007). Cooperation implies spontaneous and voluntary joint work that is not caused by externally controlled mechanisms. Some forms of cooperation are exchanging ideas and materials, joint activities, internships, and concentrated reflective questioning (Brust Nemet, 2015). The review results of Vangrieken et al. (2015) showed that teacher collaboration pays off for students, teachers, and the whole school. Teachers appear to profit from the collaboration not only in terms of job performance but also on a personal level. Furthermore, the review showed that students' educational performances progress when teachers collaborate. The MetLife Survey of the American Teacher shows that teachers spend 2.7 hours per week in structured collaboration with other teachers and school leaders (Met Life, 2010). "The most frequent types of collaboration among teachers and school leaders are teachers meeting in teams to learn what is necessary to help their students achieve at higher levels; school leaders sharing responsibility with teachers to achieve school goals; and beginning teachers working with more experienced teachers" (MetLife, 2010, p. 16). Research (Gruenert, 2005; Moller et al., 2013) among teachers in primary schools in America and Colombia showed that creating a professional community whose main feature is cooperation among teachers significantly impacts student success. It has been demonstrated when teachers collaborate, they have a greater desire to learn and practice, thus improving student learning (Hairon et al., 2015).

Schools with higher degrees of collaboration are associated with shared leadership and higher levels of trust and job satisfaction (MetLife, 2010, p. 16). Existing research in the USA shows that teachers believe that most collaborative activities are valuable and effective use of time. Teachers reported participating in various collaborative activities, mostly focusing on improved teaching, planning within grade level, and students' academic growth. Although 100% of the teachers believe these are valuable collaborative activities, less than 75% reported participating (Tichenor & Tichenor, 2019). Another study explored teachers' views about professional cooperation levels between general education teachers and other specialisation teachers with a reformed comprehensive curriculum in Greek schools. Regarding cooperation

levels in teaching, 160 teachers reported cooperation, support, conciliation, security, companionship, sharing, respect, acceptance of different views, common targets they may express, the agreed-upon problem-solving approaches they can apply, and effective communication and ideas exchange about school issues as a team. Teachers indicated that they co-operated mostly in implementing joint project-based learning and/or school cultural events/school festivals and facing pupil behavioural and learning issues, especially in difficult family situations. Teachers can cooperate best with colleagues who are open-minded in cooperation and pedagogically competent (Tzika et al., 2019).

### **Cooperation between teachers on projects through the eTwinning platform**

Computerised technology is integrated into all aspects of our lives, including education. eTwinning promotes lifelong learning and aims to network schools with the help of ICT. The formal education process is no longer viewed as happening only within the solid walls of formal educational institutions (Galvin et al., 2007). Teachers must have the skills to use information and communication technologies effectively and improve themselves. eTwinning is a platform that enables teachers to improve themselves (Acar & Peker, 2021). One of the main objectives of eTwinning is to promote the use of ICT in education using email, web pages, blogs and vlogs, videoconferencing, and the Internet (Galvin et al., 2007). There are eight key competencies according to the Recommendation on key competencies for lifelong learning in 2018: literacy competence, multilingual competence, mathematical competence and competence in science, technology and engineering, digital competence, personal, social and learning to learn competence, citizenship competence, entrepreneurship competence, cultural awareness and expression competence. Competence-oriented approaches should be embedded in the educational staff's initial training and continuous professional development. Educational staff must be supported in developing innovative competence-oriented approaches such as collaborative peer learning, staff exchanges and mobility, and participation in networks and communities of practice (European Commission, European Education and Culture Executive Agency, 2018).

Launched in 2005, the eTwinning community comprises thousands of school staff who use information and communication technology (ICT) meaningfully. It has involved more than 1 053 000 school staff working in more than 233 000 schools across more than 40 countries. eTwinning is a safe digital platform that is free of charge. Educators and other school staff from early childhood education and care to upper secondary schools are engaged in various activities: designing and implementing European collaborative projects, networking, participating in

virtual groups, professional development, and peer learning. Through its platform, which is available in more than 30 languages, eTwinning provides teachers with various resources and learning opportunities. As of 2022, the eTwinning community has been hosted within the European School Education Platform. The European School Education Platform and the eTwinning community are funded by Erasmus+, the European program for education, training, youth and sport, and by the support of the National Support Organisations, funded by Erasmus+ under grant agreements with the European Education and Culture Executive Agency, and the Supportive Partners (European Commission, European Education and Culture Executive Agency, 2023). eTwinning provides the opportunity to improve language skills, learn about Europe, and contribute to constructing a European identity and citizenship by operating in the field of learning (Manfredini, 2007).

E twinning has opportunities for teachers' collaboration and professional development:

- “• eTwinning can stimulate collaboration with colleagues within and outside the school.
- It can improve the relationship between students and teachers.
- It provides powerful learning for the teachers by working with others from other cultures. It stimulates the exchange of ideas and makes the sharing of educational knowledge and know-how possible.
- Teachers can contact experts directly, if they need something for their lessons.
- It can stimulate teachers to develop learning materials in cooperation.
- It helps exchanging material that has been tested by colleagues elsewhere.
- It allows teachers to implement new ways of teaching practice (grouping, methodology, motivation...) and leads to pedagogical innovation.
- Teachers develop intercultural communications skills by using ICT in a realistic way.
- It helps to develop cross-cultural and management competencies and helps strengthen teachers' personalities.
- The teachers' eTwinning community and the more playful approach help them to use ICT-Tools in specific learning” (Galvin et al., 2007, p. 26-27).

Professional development is one of the main pillars of eTwinning, as it involves training on diverse themes and pedagogical topics. Professional development activities include short online courses, webinars, workshops or on-site courses organised in different countries (before



the pandemic), conferences and webinar series. Additional ways of promoting teachers' professional development include networking events and participation in eTwinning Groups and eTwinning Featured Groups (European Commission, European Education and Culture Executive Agency, 2022).

The 2023 monitoring report focuses on initial teacher education and on the initiative 'eTwinning for future teachers' to explore the impact of eTwinning on student teachers, teacher educators and initial teacher education institutions. The data were obtained through focus groups and interviews conducted with student teachers and teacher educators from seven institutions nominated for the 'eTwinning for future teachers' European award for initial teacher education in 2022.

The report shows that:

- eTwinning has been integrated into undergraduate, postgraduate, master's degree courses and in-school placements.
- eTwinning contributed to internationalising institutions, thus promoting transnational collaborations, inclusion, and openness.
- Student teachers reported that eTwinning affected their intercultural, digital, and pedagogical competencies in their online collaboration with peers across Europe and gained a better understanding of teaching, which increased their motivation and the attractiveness of the teaching profession.
- Teacher educators reported that eTwinning positively affected their professional development in their interactions with their peers in the eTwinning community, the implementation of eTwinning projects, and the professional development activities they attended (European Commission, European Education and Culture Executive Agency, 2023).

## **Review of research on the professional development of teachers participating in eTwinning projects**

### ***Method***

The aim of this paper is to determine the representation of the topic of professional development of teachers through participation in eTwinning projects. In accordance with the goal of the work, the following research questions were formulated:

1. What is the representation of the topic of professional development of teachers through participation in eTwinning projects in terms of the number of papers and the year of publication?

2. What are the advantages and disadvantages for teachers participating in eTwinning projects?

The research was conducted using the method of document analysis, followed by content analysis of scientific articles. Articles were found in the Web of Science and Scopus databases. The search was limited to scientific articles written in English, published from 2020 to 2024.

### ***Research results and discussion***

By reviewing the relevant scientific literature in the Web of Science and Scopus database, we found 8 scientific research papers that established that educators have positive attitudes about professional development, mobility and collaboration through projects on digital platforms (Acar & Peker, 2021, 2024; Alireisoğlu, 2023; Başaran, 2020; Gökbulut, 2023; Huertas-Abril & Palacios-Hidalgo, 2023; Kizilaslan & Başkanefl, 2023, Uslu Kaplan & Alkan, 2023).

Acar & Peker (2021) was conducted among 15 volunteer teachers working in Konya, Turkey's state elementary, secondary, and high schools in the academic year 2019-2020. The results showed that eTwinning significantly improves teachers' professional and personal development. The teachers stated about their personal development that eTwinning improved their self-confidence, communication skills, feelings of solidarity, sense of belonging to the community and foreign language skills. The teachers stated their professional development that eTwinning contributed significantly to their technology and pedagogy knowledge, increased their technology knowledge, learned new teaching methods, provided acculturation, and improved their foreign language skills.

Similarly, Acar and Peker (2024) conducted another study proving that eTwinning positively affects teachers' professional and personal development. 15 volunteer teachers from different branches working in public schools in Konya province in Turkey in the academic year 2019-2020, who had experience in eTwinning projects participated in the study. The findings obtained in this study showed that eTwinning projects had advantages, such as improving learning/teaching, cultural interaction, self-confidence and language development. The research also examined the disadvantages of eTwinning projects; half of the participant teachers stated

that there were no disadvantages, while half of them stated that the projects had disadvantages, such as taking too much time and requiring sacrifice.

In the study, the impact of The eTwinning Project on Teachers' Collaborative Working Competence was observed. Teachers' ability to work together is generally high, while teachers who take part in eTwinning studies have a significantly higher level. Findings show that eTwinning studies positively affect students, teachers, and institutions. It has been concluded that teachers can participate in project studies in line with their personal and professional characteristics related to their competence to work together and that their competence to work together is affected by the tasks they take on the project (Alireisoğlu, 2023).

eTwinning aims to provide opportunities for collaborative work and communication between schools in European countries using ICT and establishing national and international partnerships. The research about how eTwinning projects reflect teachers' professional development was conducted with 24 teachers working in various provinces of Turkey who participated in the eTwinning projects in the 2019-2020 academic year. Teachers described their eTwinning projects as cooperation, sharing, technological development, innovation, communication, friendship, creativity, productivity, development and sacrifice. In addition to that, teachers find eTwinning projects useful, especially in terms of using technology and integrating technology into the lesson, as they share activities through the portal. The case study concludes that eTwinning projects positively affect teachers' professional development (Başaran, 2020).

The study aimed to determine the digital literacy levels of teachers working in Turkey and other member countries on the eTwinning platform. The research found that the digital literacy levels of the teachers working in Turkey and those in the European Union eTwinning network member countries are high, with no statistically significant difference between the gender variable and digital literacy. The teachers participating in eTwinning projects stated that they significantly impact their professional development and students, European culture, schools and teaching, respectively. The results show that eTwinning projects contribute to the professional development of teachers in terms of the use of technology, pedagogical methods, use of Web 2.0 tools, digital literacy and understanding of Generation Z (Gökbulut, 2023).

Huertas-Abril and Palacios-Hidalgo (2023) conclude that the research on pre-service language teachers' digital literacy who have participated in the 'eTwinning for future teachers' initiative is limited. Therefore, they researched how eTwinning can enhance teachers' digital skills by involving 76 pre-service language teachers from two European universities, University of Cordoba, UCO (Spain) and University of Lower Silesia, ULS (Poland). A questionnaire

assessed the digital competence of English as a Foreign Language (EFL) and bilingual education teachers. The results show that the respondents have generally positive perceptions of their use of ICT and educational technology; men tend to be more positive when thinking about their digital skills; pre-service language teachers from Spain have more positive self-perceptions regarding their use of ICT and teachers' digital competence.

Kizilaslan & Ersin Başkanefl (2023) investigated the perceptions of English as a foreign language teachers on eTwinning, who completed eTwinning projects and carried them out with EFL learners. Ten EFL teachers working at secondary and high schools in Turkey participated in the study. The data were collected through semi-structured interviews. The results showed that EFL teachers were positive about participating in eTwinning projects. They reported that eTwinning projects contributed to their professional development since they created an international network of EFL teachers, providing an opportunity to share their teaching experiences, and the international network developed their technological and pedagogical content knowledge and organisational skills. Moreover, the projects motivated the teachers to plan and organise similar projects and helped them gain recognition among their colleagues and appreciation in their workplace.

The study about teachers' opinions on the contribution of eTwinning projects to their professional competencies shows that teachers involved in eTwinning projects think their participation contributes positively to their professional competence. The participants were 189 teachers, who were selected using the snowball sampling technique. The study data were collected by a questionnaire based on the General Competencies of the Teaching Profession published by the Ministry of National Education in Turkey in 2017. The study concludes that eTwinning projects helped teachers improve their professional competencies, including professional knowledge, skills, attitudes, and values based on teachers' opinions (Uslu Kaplan & Alkan, 2023).

## **Conclusion**

Cooperation and partnership with different stakeholders of the educational system can contribute to the result of the expected higher goals of the school (Stoll & Fink, 2000). Therefore, it is necessary to encourage different forms of cooperation among teachers. Undoubtedly, digital platforms play a crucial role in the internationalisation of education, enabling teachers to participate in national and international projects. This participation enhances their professional competencies and enriches the school's pedagogical culture. Teachers should be the intercultural mediators who will enter into relationships with different

cultures, create a positive school culture that recognizes diversity as a value, and, as such, position themselves in the local community while contributing to the transformation of education (Brust Nemet et al., 2021, p. 264). Byram (2018) argues that internationalism, especially mobility, has a moral dimension that can provide a normative-value basis for internationalization processes. By reviewing the scientific literature and previous research on the importance of professional development, mobility and cooperation of educational workers through projects on digital platforms (Acar & Peker; 2024; Alireisoğlu, 2023; Başaran, 2020; Gökbulut, 2023; Huertas-Abril & Palacios-Hidalgo, 2023; Kizilaslan & Başkanefl, 2023; Uslu Kaplan & Alkan, 2023) it is observed that teachers have positive perceptions about the use of ICT on educational platforms, they believe that digital competences help them to establish national and international collaborations and partnerships. The professional and personal status of the teacher develops. Teachers described their eTwinning projects as cooperation, sharing, technological development, innovation, communication, friendship, creativity, productivity, growth and sacrifice. The findings showed that eTwinning projects had advantages, such as improving learning/teaching, cultural interaction, self-confidence and language development. eTwinning projects contribute to teachers' personal and professional development because an international network is created to exchange experiences through various collaborative forms among teachers. The teachers transfer the acquired international experiences and competencies to their schools, creating a positive school culture, which contributes to a more pleasant school atmosphere and a better professional status for the teachers. About the benefits mentioned above of involving teachers in national and international collaborations, it is necessary to motivate and encourage teachers to collaborate with other teachers as much as possible because they will be more ready to respond to all the challenges of the teaching profession that are influenced by various global factors. The results of the research indicate that working on projects stimulates the professional development of teachers, therefore it is important to encourage teachers to participate in projects as much as possible. Also, it is important to conduct empirical research in the future in order to determine why many teachers do not participate in projects and how they could be motivated to participate in projects that contribute to personal and professional development.

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## Click For Friendship - Peer Relations On Social Networks

Ante Kolak, Ivan Markić and Mara Sesar

University of Zagreb, Faculty of Humanities and Social Sciences, Croatia

### Abstract

The Covid-19 pandemic and the post-pandemic period brought changes in social relationships. As a response to the new situation, the virtual world offered a variety of opportunities to maintain and create social relationships.

The aim of this paper is to determine the representation of the friendly peer relationships in the period during and after the pandemic in the leading global and local databases, and to determine the possible directions provided by the researched sources in response to present challenges in the field of education.

The research was conducted by the documentary research method, and it was followed by the analysis of the content of textual primary sources. The scope review followed the guidelines recommended in PRISMA-ScR (Page et al., 2021) and remained limited to scientific articles on peer friendships on social networks published between 2021 and the time of writing (January 2024). The scientific articles, published in English and Croatian, were found in the Web of Science and Scopus databases and on the Portal of Croatian scientific and professional journals Hrčak.

The research results quantified a total of 47 scientific papers. Empirical papers prevail over theoretical ones and the quantitative paradigm prevails in empirical papers. The analysis of the documentation revealed a diverse structure of research participants and only a small number of articles dealt with participants with special educational needs. In the conclusions, the analysed articles mostly focused on the positive and negative aspects of the use of social networks and on the quality of friendships on social networks.

*Keywords:* peer relations, social network, friend, online friendship

## **Introduction**

Social networks such as Instagram, WhatsApp, Facebook, WeChat and TikTok are used as accelerators in interpersonal communication and have become the simplest way to communicate with each other (Diklić et al., 2019). They enable connecting with family, friends, coworkers, acquaintances, but also with those who are just strangers in the real world. They are a new location for creating/maintaining existing relationships, making them an interesting subject of research for experts from various fields, including pedagogues. Relationships on social networks were emphasized during the coronavirus pandemic when lockdown was introduced as a method of disease spread prevention. Closed school doors and halls, as well as legal provisions that prevented gatherings, opened the door wide open to the potential of online relationships on social networks.

Relationships on social networks, in an online environment, can be categorized in various ways (according to the type of media used, network, participants' age, level of interaction, etc.). In this paper, the authors direct their thoughts towards one of the most affected groups – young people, and towards determining the changes that have occurred in their lives, especially in peer friendships – which have been the subject of scientific research and the results of which have been published in various databases. Creating and maintaining friendly relationships with a peer of the same age is extremely important for acquiring primary social experience and is the basis through which a child learns to cope with conflicting situations (Berndt, 1983, as cited in Klarin, 2000). The benefits of friendship include emotional security, positive self-image, satisfaction, social competence, fulfilment of intimacy needs and adoption of prosocial behaviour norms (Kolak & Markić, 2020). Since the pandemic and post-pandemic periods have had significant consequences on life, functioning, and peer relationships, the authors of this paper have directed their scientific research interest towards determining the topics that scientists around the world, as well as in the Republic of Croatia, have dealt with in the field of peer friendships, forced by circumstances to move to an online environment in order to clarify what the pandemic caused and to offer appropriate responses.

## **Method**

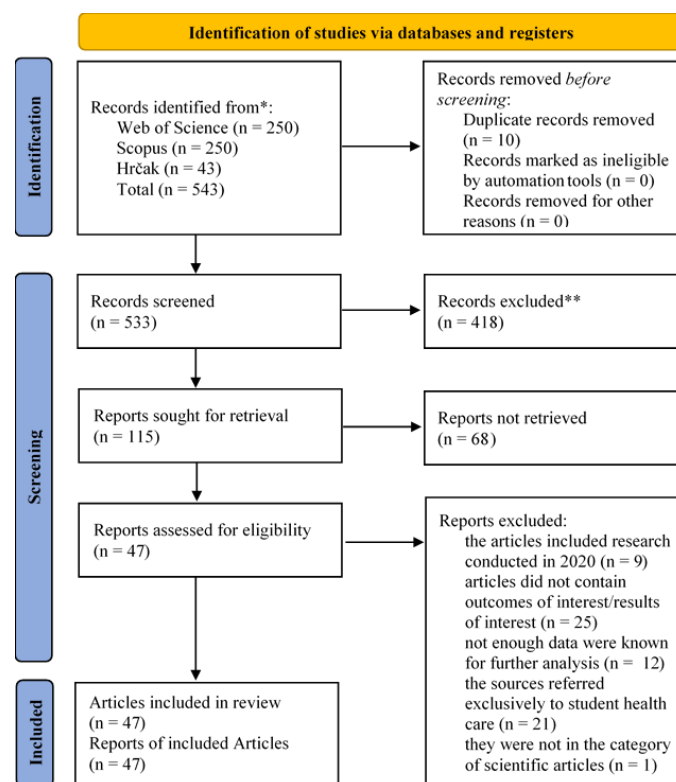
The aim of this paper is to determine the prevalence of the topic of peer friendships on social networks during and after the pandemic in leading global and domestic databases, and to ascertain the extents to which the researched sources provide responses to the present challenges. In line with the set objective of the paper, the following research questions have been formulated:

1. What is the prevalence of the topic of peer friendships on social networks in terms of the number of papers, year of publication, and methodological approach?
2. What are the findings of the selected scientific papers?

The research was conducted using a document analysis method, followed by content analysis of scientific articles. The scope review followed the guidelines recommended in PRISMA-ScR (Page et al., 2021), exclusively including scientific articles while other categories of papers (such as conference proceedings, book chapters, etc.) were not included.

The articles were found in Web of Science and Scopus databases, as well as Croatian scientific and professional journals portal Hrčak. The search was limited to scientific articles written in Croatian and English, published from 2021 until the time of writing the paper (January 2024). In the preliminary search in the mentioned databases and portal, there was no systematic review of scientific articles related to peer relationships on social networks. By using keywords while searching in the databases and on the portal (*Online friend, Virtual friend, Internet friend, Online connection, Social media friend, Child social media*), a total of 543 scientific articles were reviewed. Then, a check for duplicates was conducted (from the Web of Science and Scopus databases) and 10 duplicates were identified. The articles were reviewed based on their titles and abstracts, followed by a more thorough check for those articles that did not have sufficient data. This involved translating abstracts from English to Croatian to definitively ascertain the acceptability of a particular article. According to these criteria, 86 scientific articles were selected from the Web of Science database, 32 scientific articles from the Scopus database and 7 scientific articles from the Hrčak portal. In the next phase, the eligibility of articles was assessed according to the categories specified in the research questions. Some reasons for excluding articles, besides the mentioned duplicates, included: articles involving research conducted in 2020 (although sources were selected based on the year of publication, an attempt was made to avoid those articles whose research was conducted much earlier than the year of publication of the article and/or articles whose research specifically depicted the situation at the beginning of the pandemic), articles lacking outcomes of interest/results of interest, insufficient data available for further analysis, sources solely focusing on student healthcare, articles categorized incorrectly. Therefore, articles that did not meet the eligibility criteria were excluded, and it was conclusively determined: according to the previously mentioned keywords, 86 articles were found in the Web of Science database, of which 35 met the inclusion criteria; 32 articles in the Scopus database, of which 8 met the inclusion criteria; 7 articles on the Hrčak portal, of which 4 met the inclusion criteria (Figure 1.

PRISMA 2020 flow diagram of included articles). The synthesis of sources was based on the sources of scientific articles, article themes, year of publication, methodological research approach and results. Articles were sorted alphabetically.



*Figure 1. PRISMA-ScR 2020 flow diagram of included articles (Page et al., 2021)*

## Results and discussion

The entire process of acceptance/exclusion/selection of scientific articles is shown in the PRISMA-ScR flow diagram (Figure 1. PRISMA-ScR 2020 flow diagram of included articles). The articles correspond (directly or indirectly) to the theme of peer relationships on social networks. The research results quantified a total of 47 scientific papers, of which 35 were found in the Web of Science database, 8 in the Scopus database, and 4 articles on the Hrčak portal. The highest number of articles was published in 2022 (N=20), followed by articles published in 2023 (N=16) and 2021 (N=9) and a total of 2 articles were published in January 2024 (Table 1. Publication time of articles).

*Table 1. Publication time of articles*

Publication year	Total number of articles
2021.	9
2022.	20
2023.	16
2024. (January)	2

Empirical studies (N=38) dominate over theoretical ones (N=9), with the majority of articles with a quantitative research paradigm (N=24), followed by articles with a qualitative research paradigm (N=12) and articles utilizing a mixed research approach (N=2) (Table 2. Methodological approach of researchers in selected articles).

*Table 2. Methodological approach of researchers in selected articles*

Quantitative research	24 articles
Qualitative research	12 articles
Mixed method research	2 articles

By reviewing selected articles, categories were established according to which the selected articles were classified based on the conclusions they draw. Based on the above, the following categories were determined:

- Friendship relations on social networks
- Consequences of using social networks

In the first category, articles whose results indicate that online friendships are in line with offline friendships were selected (DeSouza et al., 2022; Dodel et al., 2021; Scott et al., 2021; Sutcliffe et al., 2023; Yuan & Lee, 2021; Yue et al., 2023). In this way, we cannot speak of alienation in friendly relationships, but rather of the potential of virtual networks as a means of mediation that facilitate the maintenance of various dimensions of friendship, especially availability, as confirmed by the research of Angelini et al. (2022), as well as intimacy, which Hatamleh et al. (2023) and Winstone et al. (2021) highlight as a key aspect of relationships on social networks. There are also research findings indicating that young people primarily describe relationships and friendships on social networks as contacts (without attachment), while they perceive offline friendships as real friendships (Sjeloie et al., 2023). Although the use of social networks has a strong socializing character, young people who prefer to make friendships through social networks generally do not spend time with friends after school and outside home (Donelle et al., 2021; Gutiérrez Ángel et al., 2022). Young people also perceive social networks as a space for establishing identity and belonging, but also as a space of risk where they are exposed to discrimination and unrealistic standards (Douglass et al., 2022). A particular challenge highlighted in the literature is the attention-seeking on social networks, which creates pressure and reduces friendly closeness among peers (Dumas et al., 2023), as well as uncomfortable emotional reactions such as jealousy that affect the quality of friendships (Vaillancourt et al., 2024).

Online social connections can be an easily accessible option for reducing social isolation among young people with physical disabilities and autism, as well as individuals suffering from severe malignant diseases (Bowman et al., 2024; Gillespie-Smith et al., 2021; Lazard et al., 2021; Smart et al., 2023). Lovrekovic et al. (2022) and Rosic et al. (2022) demonstrated the existence of differences in the use of social networks among adolescents depending on gender and socio-economic status, while Ameri et al. (2023) highlight that users with similar socio-demographic characteristics are more likely to become friends even on anonymous online networks. There is also a noticeable correlation between the intensity of social media use and the degree of attachment to peers, as well as the fear of missing out (Opsenica Kostic et al., 2022). These findings are consistent with previous research by Decieux et al. (2019), who emphasize the importance for cohesion and the improvement of friendly relationships.

In this category of friendships on social networks, there is also a separate category of friendships with artificial intelligence. In the total of two papers, the friendship relationship with artificial intelligence is problematized (Bosch et al., 2022; Brandtzaeg et al., 2022). The results of those articles indicate that the artificial nature of chatbots and AIs changes the concept of friendship in several ways, such as allowing for a more personalized friendship tailored to the needs of the user.

The second category focused on representation of the positive and negative consequences of using social networks. In the subcategory of negative consequences, the results of the articles indicate significant links between unfavourable family relationships of children and parents and undesirable behaviours when using social networks (Ali et al., 2022; Terrell et al., 2023). The age of the users is also significant, as studies by Charmaraman et al. (2021) and Charmaraman et al. (2022) indicate: students who have a social network at the age of up to 10 years show more problematic behaviour on social networks (more frequent checking of social networks is associated with social anxiety and social isolation). The students with ADHD symptoms also show more problematic behaviour on social networks (Dekkers & van Hoorn, 2022). Similar results are present among the adolescents, indicating that those who are addicted to social networks are insecure at school and at home and spend more time in front of screens in their free time (Gaspar et al., 2023). The results of Feijoo et al. (2023) highlight that students generally maintain two profiles on the same social network: one public where they interact with their parents and one private only for friends (indicating a lack of trust for parents) and in online conversations, they can also use AAC - augmentative and alternative communication (Grace et al., 2023).

It has been proven that content on social networks is associated with feelings of loneliness (Caba Machado et al., 2023; Lawrence et al., 2022), lower life satisfaction rates (Varga et al., 2022) and can even trigger suicidal thoughts (Lubenets et al., 2022), as well as risky and dangerous behaviours such as participating in online challenges (Astorri et al., 2023; Hayes et al., 2022). Shin et al. (2022) indicate that depressive symptoms may be linked to the subjective experience of using internet media. Negative consequences of online experiences can also vary depending on gender (Brajša Žganec et al., 2022), and there is a visible correlation between online friendships and online gaming addiction (Son et al., 2021).

In the student population, there is a trend of increasing prevalence of online communication, but the main drawbacks of online communication are cited as the lack of nonverbal communication, the inability to express thoughts and feelings accurately and the inability to actively listen (Primorac & Primorac Bilaver, 2022).

In the subcategory of positive consequences, the results of the articles indicate that limiting time spent on social media leads to a reduction in depression and fear of missing out (Hunt et al., 2023). Feeling support, communication and connection are identified as advantages of social networks by students (Bibizadeh et al., 2023). Also, a correlation has been found between time spent online and life satisfaction (Milosevic et al., 2022), as well as the positive impact of social networks on the process of social learning (Brown et al., 2023). Considering the observed contradictions in the advantages and disadvantages, the authors emphasize the importance of conducting longitudinal studies to determine the exact relationship among time spent on social media, online friendships and mental health.

## **Conclusion**

Friendships on social networks indicate ambiguity. Some participants identify online friendships with offline friendships and use online platforms as aids in maintaining availability. On the other hand, some results suggest a clear distinction between online friendships and offline friendships, with online friendships lacking a sense of attachment. Some results indicate alienation as the quality of online friendships is associated with absence in the real-life interactions (hanging out outside of school and after school obligations). The negative aspects of online friendships align with the negative consequences of using social networks. Overall, negative aspects include difficulties related to mental health, social anxiety, social isolation, dissatisfaction with oneself, problematic behaviours, feelings of loneliness, addiction, and low life satisfaction. Individuals with special needs highlight the benefits of online friendships and

social networks. Limited time spent online contributes to reducing depression, fears and many other negative consequences.

One of the fundamental components of building relationships and friendships is being close and having the ability to communicate. Various researches have shown that, if we want to create the connections necessary for friendship, we must have constant access to each other (Kolak & Markić, 2020). The online world offers new opportunities for creating and maintaining friendly relationships by creating new conditions for social experiences and new ways of interaction. External factors that have influenced friendships such as place of residence, social status, or common extracurricular activities (Rawlins, 1992) take on a new and different dimension. Therefore, it is necessary to systematically explore and understand the ways in which young people interact and maintain friendships, as well as understand how they deal with various social and communication challenges. The 'click' opens up possibilities, especially in terms of availability, but it is not sufficient for fulfilling all the necessary dimensions of a friendly relationship.

The researched issues point to the need for future reflections and empirical research on peer friendships on social networks. Considering the results of available research, we emphasize the importance of the role of educational institutions and highlight the need to enrich curricula which will be focused on nurturing a culture and etiquette of communication, but also on building the competence of young people to properly integrate the online world into real life.

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## **Self-Assessment Of Digital Competencies Among Students At The University Of Slavonski Brod**

Višnja Vekić-Kljaić<sup>1</sup> and Luka Pongračić<sup>2</sup>

<sup>1</sup>Faculty of Education, University of Osijek, Croatia

<sup>2</sup>Department of Social Sciences and Humanities, University of Slavonski Brod, Croatia

### **Abstract**

Digital competencies of students are becoming increasingly important in contemporary society, enabling students to successfully meet the demands of the academic, professional, and social communities. These competencies encompass a wide range of skills and knowledge related to the use of Information and Communication Technologies (ICT). Higher education institutions increasingly recognize the importance of integrating digital competencies into the curriculum to prepare students for the challenges of the modern work environment. Continuous improvement and monitoring of technological trends are also crucial for maintaining the relevance of digital competencies throughout one's career. The aim of this research is to establish the connection between the self-assessment of digital competencies among students at the University of Slavonski Brod and different selected factors. The objective is to determine whether students of different genders, majors, levels, durations, and study programmes significantly differ in the self-assessment of their digital competencies and programming experience. The methodology is quantitative and involves the analysis of self-assessment questionnaire results. Non-parametric methods were used, and the results indicate that students of the Integrated Undergraduate and Graduate University Teacher Education Program show the highest level of self-assessment of digital competencies. Students of the Undergraduate University Program in Eco-Engineering and Nature Protection demonstrate the most significant programming experience, while female students have more programming experience than their male counterparts. The research results can serve as a stimulus for improving study programmes.

*Keywords:* contemporary society, digital competencies, programming, students, study programmes.

## **Introduction**

The future job market expects students to possess various competencies and skills to be competitive and successful. In addition to expertise in their field of study, students need problem-solving skills, communication skills, flexibility, and the ability to quickly adapt to new situations and information (Holzer, 2019). They also require an entrepreneurial and team spirit, as well as digital or technological literacy, which involves a basic understanding of computer programmes and the ability to quickly adapt to new technologies. In the Recommendations of the Council of the European Union on key competencies for lifelong learning (2018), digital competency implies the safe, critical, and responsible use of digital technologies. It includes information and data literacy, communication and collaboration, media literacy. Digital competency is a complex competency that consists of numerous areas of knowledge, and requires knowledge, attitudes, and skills to achieve activities in the digital environment. Caena and Redecker (2019) state that digital competencies that every citizen should develop for a successful life in a digital society, breaking them down into five areas, are as follows: information and data literacy, communication and collaboration, digital content creation, safety, and problem-solving. Taking these aspects into consideration, students should develop their competencies through coursework, as well as through additional activities such as internships, volunteering, and continuous learning to better prepare themselves for the demands of the future job market.

The ability to analyse and interpret data is increasingly crucial in various fields, given the exponential growth in data production (Carlsson, 2009). Students should develop skills in working with data analysis tools and understand how to make informed decisions based on data. Understanding the basics of digital marketing, including social media, email marketing, and analytics, can be highly beneficial in various industries. Piñeiro-Otero (2016) provides a comprehensive overview of digital marketing strategies, while Bala and Verma (2018) emphasize the cost-effectiveness and commercial impact of digital marketing, particularly through social media. Järvinen and Karjaluoto (2015) highlight the importance of web analytics in improving digital marketing performance, with the latter specifically focusing on its use in the industrial companies. These studies collectively underscore the value of digital marketing knowledge in enhancing business success.

Understanding the basic principles of cybersecurity is becoming important for personal protection and information security (Sridhar, 2019; Herrmann & Pridöhl, 2020). As our reliance on information technology grows, the need to protect data, systems, and applications becomes increasingly important (Sridhar, 2019). The field encompasses various subdomains, including



data protection, network security, and defence against common attack strategies (Herrmann & Pridöhl, 2020).

Personal cloud storage services can be leveraged to provide shared storage for team collaboration, improving convenience and safety (Ning et al., 2014). A collaborative team-based cloud storage system can enhance collective content management and ensure efficiency and stability (Lim et al., 2016). The usage of cloud-based collaboration services is positively influenced by teamwork quality and computer self-efficacy, leading to improved team performance (Qin et al., 2016). Cloud computing tools, including synchronized tools, Learning Management System (LMS) tools, and social networking tools, offer opportunities for collaborative learning activities (Al-Samarraie et al., 2018).

The skills in working with design tools, graphic image processing, video, and sound can be useful in many industries, including marketing, media, and creative sectors. In the field of instructional design and technology, multimedia production competencies are essential, with a focus on the skills such as video and sound editing (Sugar et al., 2012).

Understanding social media, online communication, and building a professional online presence are important elements in the contemporary world of work. In addition to technical skills, students should also develop general digital literacy, which includes the ability to think critically about information on the Internet, ethical use of technology, and understanding online privacy (Meyers et al., 2013). Balancing these digital competencies with traditional skills can help students be more competitive in the job market. It is also important to continuously monitor the trends and adapt to the rapid changes in the digital environment.

Programming is becoming increasingly important in environmental engineering as it enables the solving of complex problems related to environmental conservation. Students with programming experience can develop tools and systems that contribute to sustainable solutions. Programming can facilitate the implementation of sensors, monitoring systems, and analytical tools for assessing the quality of air, water, soil, and other environmental aspects. Students can contribute to the development of innovative solutions for monitoring and maintaining ecological balance. Programming enables the creation of models and simulations that aid in understanding ecological processes, predicting the impact of human activities on the environment, and testing different scenarios for nature conservation. Programming allows students to integrate their environmental knowledge with computer skills, promoting an interdisciplinary approach to addressing environmental challenges. In their research, Bezbaruah and Lin (2008) highlight the potential of programming to enhance the learning experience in the field of environmental engineering and nature conservation. They designed a course in

environmental management for engineering and natural science students, incorporating real-world problems and interdisciplinary perspectives.

### **Literature review**

A range of studies have explored the digital competencies of higher education students and their benefits. Martzoukou et al. (2020) found that students' self-perceived digital competencies were linked to their previous experiences in the digital environment, with a need for a more comprehensive approach to digital literacy. Popa and Topală (2018) highlighted the correlation between students' self-directed learning and their digital competencies, with a more favourable attitude towards digitalized learning in technical specializations. Vasylyshyna (2020) identified the benefits of digital learning, including personalized and collaborative learning, and the development of problem-solving skills. Kuzminska et al. (2018) emphasized the importance of digital competencies for both students and teachers, and proposed a model for determining these competencies. These studies collectively underscore the need for a holistic approach to digital competencies in higher education, with a focus on self-directed learning, digitalized learning, and the development of problem-solving skills.

Okoro et al. (2012) and Endersby et al. (2017) highlight the role of digital platforms in enhancing collaboration skills and networking with colleagues, with Okoro emphasizing the benefits of Web 2.0 technologies in education, and Endersby et al. (2017) proposing a framework for assessing leadership competencies in the digital space. Rodríguez-García et al. (2022) and Kozheko (2023) further emphasize the need to improve digital competency, especially in the context of gender differences and the development of communication skills in higher education. Together, these studies emphasize the crucial role of digital platforms in fostering effective online communication and collaboration.

Petrucco and Ferranti (2017) and Kong (2014) both highlight the role of critical thinking in evaluating online information and developing information literacy. The research results of Kong (2014) demonstrate a statistically significant growth in information literacy competencies and critical thinking skills when they are taught daily in the classroom.

A range of studies have explored the self-assessment of digital competencies among students of teacher education. Martzoukou et al. (2020) found that students often lack competencies in information literacy, digital creation, research, and identity management. Popa et al. (2018) further noted that students' self-directed learning and self-efficacy are positively correlated with their digital competencies. Kuzminska et al. (2018) emphasized the importance of digital competencies for both teachers and students, and Llopis Nebot et al.

(2021) highlighted the need for assessment tools to help faculty reflect on their digital competencies.

As for the opinions about successful computer science professionals, both female and male students emphasized hard working, detailed oriented approaches, and enjoying playing with computers (Stoilescu & Egodawatte, 2010). Despite this, female students catch up to their male counterparts in terms of programming mastery by the end of their introductory courses (Murphy et al., 2006). However, male students tend to have higher prior conceptual and strategic knowledge in programming, while female students excel in syntactic programming knowledge (Yurdugüla & Aşkar, 2013). The research has shown that female students demonstrate greater programming experience than male students, which may indicate several possible factors and dynamics within the educational context.

The following section is on methodology for researching students' digital competencies in further work.

## **Methodology**

### *Research objectives, problem, and hypotheses*

The aim of the research is to determine the level of self-assessed digital competencies of students and the diversity of self-assessed digital competencies according to gender, study programme, type and level of study, and programming experience. Self-assessment of students' digital competencies refers to their ability to assess their own digital skills and understand the level of their digital literacy. This assessment can be important for students to better understand their strengths and weaknesses in the field of digital technologies and to identify the areas that need some improvement. Self-assessment of digital competencies is important for continuous personal and professional development. From the stated research objective, the following hypotheses are defined:

H1: A high level of self-assessed digital competencies of students is expected.

H2: Differences in the self-assessment of the level of digital competencies are expected among students of different study programmes, genders, levels, and durations of study.

H3: Differences in the self-assessment of programming experience are expected among students of different study programmes, genders, levels, and durations of study.

## Participants

At the University of Slavonski Brod in the Republic of Croatia, there are 1968 enrolled students. There are 832 students in their final year of study. The research involved 159 students (61.6% female, 37.7% male, and 0.6% undecided), which represents 19% of the final year students. Table 1 shows the number of students according to study programmes.

**Table 1.** Number of students by study programmes

Study programme	N	%
Mechanical engineering	52	32.7
Economy	33	20.7
Eco-engineering and nature protection	3	1.9
Teacher studies	23	14.5
Preschool teacher studies	48	30.2
Total	159	100

By the length of study, 40.3% of students are from the undergraduate programmes, while 59.7% are from the graduate programmes. According to the type of study, 61.6% of students are full-time, while 38.4% are part-time students studying while working. Regarding the level of study, 32.1% of students are from the professional studies, while 67.9% are from the university studies.

## Research instrument and procedure

The research was conducted online using a questionnaire developed for assessing students' competency levels. The study took place at the end of 2023 at the University of Slavonski Brod. A link to the questionnaire, along with a request to participate in the research, was sent to the common email addresses of final year students in various study programmes. Participation in the research was voluntary and anonymous.

The first part of the questionnaire included questions about participants' general socio-demographic data (gender, study programme, length of study, type of study, and level of study).

The second part of the questionnaire consisted of questions about students' digital competencies, comprising nine items. In seven items, participants were asked to rate the level of digital competencies listed in the questionnaire using a 5-point Likert scale (from 1 - very low, to 5 - very high). Students assessed their basic understanding and use of digital tools, ability to quickly adapt to new technologies, critical thinking skills regarding internet information, problem-solving skills through the application of digital technology, use of digital platforms for networking and collaboration, knowledge of cybersecurity, and ethical issues in the digital environment. The question regarding programming experience was a yes/no response, and one open-ended question allowed for a short answer or suggestion for improving the development of digital competencies.

The reliability of the questionnaire was assessed using the Cronbach's Alpha test, which showed highly acceptable reliability with  $\alpha = 0.935$  (Taber, 2017).

## Results

Based on the descriptive data for students' digital competency, it is possible to observe that students from all study programmes highly rated their digital competencies on a scale from 1 to 5 ( $m = 4.14$ ,  $SD = .593$ ), as shown in Table 2. According to individual items, students rated themselves highest in the use of digital platforms for collaboration and networking with peers (42.8% of students), while they rated themselves lowest in the ability to critically think about information found on the Internet (28.9% of students).

On the item "My knowledge of cybersecurity and ability to protect personal data online", students showed the lowest self-assessment result ( $m = 3.88$ ,  $SD = 1.021$ ), while on the item "My basic understanding and use of digital tools (e.g., computer operating systems, text editors, browsers)," students showed the highest self-assessment result ( $m = 4.28$ ,  $SD = .695$ ).

Students from the Integrated Undergraduate and Graduate Teacher Studies showed the highest level of self-assessed digital competencies ( $m = 4.255$ ,  $SD = .563$ ), as shown in Table 3.

**Table 2.** Assessment of the level of digital competency of students at the University of Slavonski Brod

	Digital competencies
mean	<b>4.14</b>
Std. Deviation	<b>.593</b>
N	159

**Table 3.** Assessment of the level of digital competency by study programme

Study programme	Mean	N	Std. Deviation
Mechanical engineering	4.195	52	.529
Economy	4.138	33	.697
Eco-engineering and nature protection	3.381	3	.644
Teacher studies	<b>4,255</b>	<b>23</b>	.563
Preschool teacher studies	4.077	48	.575
Total	4.141	159	.593

To determine which study programme shows the highest programming experience, a Kruskal-Wallis H test was conducted. The results ( $\chi^2(4) = 13.294$ ,  $p < 0.05$ ) showed that statistically significant highest self-assessment of programming experience was demonstrated by students of the undergraduate university study programme in Eco-Engineering and Nature Protection (mean rank = 108.00), as shown in Table 4.

**Table 4.** Assessment of programming experience by study programme

Study programme	Mean rank	N	Chi-Square	Df	p
Mechanical engineering	65.19	52			
Economy	91.14	33			
Eco-engineering and nature protection	<b>108.00*</b>	<b>3</b>	13.294	4	.010
Teacher studies	83.80	23			
Preschool teacher studies	84.81	48			

To determine the difference in self-assessed programming experience based on gender, a Wilcoxon W rank-sum test was conducted. The results ( $W = 4258.00$ ,  $Z = -1.151$ ,  $p > 0.05$ ) showed that female students have higher programming experience than male students, as indicated, but there is no statistically significant difference (Table 5).

**Table 5.** Assessment of programming experience by students' gender

Gender	Mean rank	N	Z	p
Female	83.86	99		
Male	72.19	59	- 1.151	0.060
Total	3.94	158		

## Discussion

The aim of this research was to determine the perception of digital competency for jobs and future areas of work among the final year students at the University of Slavonski Brod. The research problem includes the level of digital competencies of students in individual study programmes during their final year of study. Overall, students' self-assessment of their level of digital competencies indicates a high level. This study is in line with other studies that have similar results. A range of studies have explored students' self-assessment of their digital competencies, revealing both high levels of self-assessment (Semiz & Čutović, 2022) and areas of deficiency, particularly in information literacy, digital creation, research, and identity management (Martzoukou et al., 2020). These competencies are influenced by the previous experiences in the digital environment (Martzoukou et al., 2020) and are not always commensurate with students' status as *digital residents* (Cabezas González & Casillas Martín, 2017). The frequency and complexity of technology usage, as well as the level of self-directed learning, are positively correlated with self-perceived digital competencies (Popa & Topală, 2018). A high level of digital competencies provides students with a range of advantages and opens doors to various opportunities in education and the job market. Digital competencies are relevant in many sectors, from information technology and engineering to marketing and education, offering a wide range of career opportunities.

If students have rated themselves as most competent in using digital platforms for collaboration and networking with colleagues, it indicates that they can effectively communicate and work together on the projects with colleagues, regardless of geographical distance. This facilitates teamwork and contributes to achieving goals more quickly. A range of studies have explored the relationship between students' digital competencies and their collaboration attitudes. Mena-Guacas et al. (2023) found that students who perceive themselves as more competent in using digital tools are more likely to collaborate with their professors in virtual environments. Castaño Muñoz et al. (2021) further emphasized the importance of teacher collaboration and professional learning activities in enhancing students' digital competency. However, Dennen et al. (2023) highlighted that while students are proficient in personal networking platforms, they lack skills in professional platforms and active online activities. This suggests a need for targeted digital skills development. Lastly, Rodríguez-Moreno et al. (2021) underscored the influence of digital tools and social networks on students' digital competency, particularly during the COVID-19 pandemic. These studies collectively emphasize the importance of digital competencies in fostering collaboration and networking among students. Competency in using digital networking platforms enables students to build

and maintain professional contacts and relationships with their colleagues, professors, mentors, and other experts. Students who successfully use digital collaboration tools are skilled in working in various virtual environments. This helps them adapt to remote work or virtual teams, which are becoming increasingly common in modern business practices. In situations where distance learning is provided, the ability to use digital collaboration platforms becomes important for successful learning, communication with professors and peers, and participation in virtual discussions and projects. Through active use of digital platforms, students further develop their digital skills.

If students are rated as least competent in the ability to critically think about information they find on the Internet, it can pose a challenge in their learning process and the development of digital competencies. Other research indicates that students often struggle to critically evaluate information found on the Internet (Petrucco & Ferranti, 2017; Kong, 2014). Despite their confidence in their ability to find information online, they may lack the necessary competency. To improve competency in critical thinking about information on the internet, workshops and lectures on media literacy can be conducted, fostering open discussions and dialogues among students. Teachers and mentors can provide support and regular feedback to help students develop their skills over time. Critical thinking encourages students to actively participate in the learning process, ask questions, seek additional sources, and express their views. Critical thinking helps students discern between information coming from the reliable sources and those that may be unreliable, biased, or of poor quality. Given the prevalence of fake news and misinformation on the Internet, critical thinking is important for recognizing and avoiding the spread of inaccurate information. Students need to be able to identify potential biases or hidden motives. Critical thinking also involves awareness of digital privacy and security issues, as well as understanding how information can be used or abused.

These studies collectively underscore the significance of digital competencies in teacher education and the need for further research and support in this area. In this study, students in Teacher Studies show the highest level of self-assessed digital competencies. Contrary to the results of this research, Garzón Artacho et al. (2020) state the lack of digital competencies particularly in content creation, among teachers in the Lifelong Learning stage in Andalusia, Spain, and further emphasize the need for continuous training and development in this area. The poor quality and contribution of ICT training in initial teacher education in Norway underscores the need for a review of the quality of such training to enhance the development of professional digital competency (Gudmundsdottir & Hatlevik, 2018). Teacher Studies often include training focused on developing digital competencies relevant to the educational context.



This may involve the application of technology in teaching, the development of e-learning materials, and the use of digital tools to enhance pedagogical practices. Students are actively engaged in the learning process, encouraging them to use technology as a means of improving teaching methods and approaches. When students are provided with opportunities for practical application of digital skills through internships or projects in real school environments, it can positively impact their self-assessment of digital competencies. The awareness of the importance of digital competencies in the modern educational system can motivate students to actively work on developing these skills, which can be reflected in their self-assessment. Additionally, educational institutions and programmes can provide support in developing digital competencies through adaptable curricula and resources.

The research has shown that students in Eco-Engineering and Nature Protection demonstrate the highest programming experience, which can have several important implications and advantages. Contrary to these results, Özmen & Altun (2014) state that students often face difficulties in programming, such as lack of practice and understanding semantics.

The research on gender differences in programming has found that female students are more interested in the use of computers rather than programming, while male students view computer science as primarily a programming activity. Similar to the findings of this study, research on gender differences in programming has revealed several key findings. Burnett et al. (2010) found significant gender differences in software feature usage, tinkering/exploring software features, and confidence across different programming populations and platforms. Murphy et al. (2006) discovered that while female computer science students had less pre-college programming experience, they reported nearly equal levels of mastery of programming concepts as their male counterparts. Du & Wimmer (2019) highlighted the need to attract more females to computer programming, as they demonstrated equal or better performance in programming comprehension. It is possible that there is a strong community and mentoring support that encourages female students to engage in programming. The presence of role models and mentors among female students can create a supportive environment for the development of programming skills. If there are specific initiatives aimed at encouraging women to participate in science, technology, engineering, and mathematics (STEM) fields, this may result in increased participation of women, including programming. Social changes and increased awareness of the importance of including women in technological disciplines can result in increased interest and participation of women. Female students may perceive the importance of digital skills in today's world and job market and are therefore motivated to

develop programming skills. It is important to continue to promote equality in access to and participation in STEM fields. Different support strategies and a more inclusive approach can contribute to reducing gender-based disparities in programming and other STEM disciplines. This can also contribute to creating a more diverse and innovative working environment in the technology sector.

## **Conclusion**

In conclusion of this research, a high level of digital competencies among students at the University of Slavonski Brod is evident, with a particular emphasis on Teacher Studies and Eco-Engineering and Nature Protection programmes. Students have shown high confidence in using digital tools and technologies, which makes them competitive in the job market. Additionally, the results have highlighted the significant role of programming in environmental engineering and the need to strengthen digital competencies in that context. Moreover, the research has shown that female students have higher programming experience, suggesting the need for further encouragement of women to engage in STEM fields. These findings underscore the importance of continuous development of digital competencies among students to ensure their competitiveness and success in future work environments. Furthermore, it emphasizes the need for an inclusive approach in STEM disciplines to ensure that different genders have equal opportunities and support in developing digital skills.

Limitations of this research should be acknowledged to provide a comprehensive understanding of its scope and implications. Firstly, the study was conducted at a single university, which may limit the generalizability of the findings to other institutions or populations. Additionally, the research relied on self-assessment measures for evaluating digital competencies, which may be subject to biases or inaccuracies in self-reporting.

Furthermore, the sample size and composition, although sufficient for the study's objectives, may not fully represent the diversity of student populations within the University. Moreover, the research focused primarily on quantitative data analysis, potentially overlooking nuanced qualitative insights into students' experiences and perspectives regarding digital competencies.

Another limitation is the cross-sectional design of the study, which provides a snapshot of digital competencies at a specific point in time but may not capture longitudinal changes or trends over time. Additionally, the study did not explore potential contextual factors or external influences that could affect students' digital competencies, such as access to technology, educational resources, or socioeconomic backgrounds.

Lastly, the research did not address the effectiveness of interventions or educational strategies aimed at enhancing digital competencies among students. Future studies could benefit from addressing these limitations by employing longitudinal designs, incorporating qualitative methodologies, and exploring contextual factors to provide a more comprehensive understanding of digital competency development among university students.

Through further research and implementation of the appropriate support programmes, the promotion of digital competency development among students can continue, contributing to their personal and professional growth, as well as the overall advancement of society in the digital age.

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## **Empowering Education with Robots: Attitudes and Perception of the Integration of Educational Robots in the Curriculum**

Filip Mudri, Anita Papić and Milijana Mićunović

Faculty of Humanities and Social Sciences, Josip Juraj Strossmayer University of Osijek

### **Abstract**

Educational robots have a moderate but significant positive effect on learning outcomes. They are consistent with contemporary learning theories, supporting active learning, social constructivism, and constructionism. They also have a positive impact on student behaviour and development, most notably in the areas of problem solving, collaboration, motivation to learn, participation and engagement in the classroom. This research investigates attitudes and perceptions regarding opportunities and challenges of integrating educational robots into the teaching and learning process, as well as expectations regarding the future use of robots in education. The study uses an online survey to examine the attitudes, opinions, and perceptions of young and mature adults engaged with the Croatian educational system, from their perspective of either student or teacher. The findings suggest that educational robots contribute to improving students' motivation and interest in the curriculum, as well as their computational and logical thinking, but also reduce their anxiety and insecurity. They also play a major role in supporting children with developmental disabilities in their education. On the other hand, the research found that the use of educational robots without sufficient involvement of teachers and peers leads to students feeling lonely and a decline in their emotional, social and communication skills. It can be concluded that while educational robots present a valuable technological advancement that empowers and transforms the educational process, they cannot replace human teachers and instructors, especially in terms of communication and social relationships. Therefore, it is necessary to employ a strategic and systematic approach to planning and implementing their integration in the curriculum.

*Keywords:* attitudes, educational robots, perception, students, teachers

### **Introduction**

The European Union (European Commission, Directorate-General for Education, Youth, Sport and Culture, 2019) emphasises digital skills as crucial for adapting to a technology-driven



society. Lately, these skills also include the use of AI-powered robots in education. In turn, the integration of robotics into education has spurred research into its role in supplementing traditional teaching and enhancing students' thinking and learning skills. Robotics in education range from virtual platforms to interactive, physical robots, that fulfil different functions, from disciplinary tools to teaching aids. Robot tutors are increasingly being used in classrooms to support teachers and promote students' growth and learning. Innovations such as intelligent assistants and virtual reality robots personalise learning, while multipurpose and specific educational robots target STEM and special education, respectively. All these 'tools' have a potential to create high-quality, inclusive, and accessible education. There are many benefits to introducing robots into education – from transforming teaching and learning experiences, supporting skills development in STEM fields and enhancing computational thinking and digital literacy skills which are critical for success in the 21<sup>st</sup> century, through fostering engagement and enhancing interactive learning, to providing personalised learning experiences and providing support in special education by assisting children with disabilities. However, integrating robotics into the classroom comes with some challenges, some of which are the costs and the need for teacher training. There is also the issue of creating universal standards, as well as considerations relating to ethics, privacy, safety, and legal responsibilities. Finally, making these 'tools' universally accessible and effective in educational settings is also challenging. But despite all the hurdles, the potential of educational robotics in shaping versatile, tech-savvy learners is undeniable. Blending into classrooms, it offers a dynamic way to foster skills that are crucial for navigating a future rich with AI and robotics. As technology advances, educational robots promise to be pivotal tools in preparing students for a future where digital and AI literacy will be essential.

### **Recent research in the field of educational robotics**

Studies in the realm of educational robotics are gaining prominence and becoming increasingly necessary, as the integration of robots into the educational system advances. Few studies on educational robotics (Anwar et al., 2019; Esteve et al., 2019; Belpaeme & Tanaka, 2021; EU Business School, 2022) address its impact on computational thinking, STEM skills, and creativity among students in the context of STEM fields. Educational robots are highlighted as tools that enhance STEM learning for students across various age groups, facilitating both basic and complex programming tasks. They prepare students for future STEM careers and future challenges in technology and engineering fields. Robots enhance students' interest, engagement, and academic achievements in STEM fields, while providing impactful learning

experiences, supporting personalised and remote learning, and simplifying programming concepts from an early age. Esteve et al. (2019) have shown that novice teachers feel digitally competent, especially in social and multimedia domains, yet struggle with technical aspects like software and hardware, which are crucial for educational robots. However, findings from Karaahmetoglu and Korkmaz (2019) revealed no notable differences in knowledge acquisition between the experimental and control groups, leading to the conclusion that robot programming activities do not significantly promote the STEM skills of high school students.

The question of the effectiveness of robots in enhancing the teaching and learning process is one of the most discussed issues in most studies (Mubin et al., 2013; Anwar et al., 2019; Alnajjar et al., 2021; Belpaeme & Tanaka, 2021; Gubenko et al., 2021; Chi et al., 2022; Wang et al., 2023; Purdue University, n.d.; Bustos Iliescu, 2023). Studies emphasise the effectiveness of educational robots in engaging diverse learners and preparing them for future technological challenges. Robots in the classroom improve the academic and social success of young students and promote a more inclusive and engaging learning environment. They have a significant positive effect on learning outcomes across all educational levels, and not just in the STEM field, but also in humanities, social sciences and natural sciences. In combination with AI technology, and thanks to their design and programming, they encourage learner creativity through engaging, hands-on activities that emphasise critical thinking, problem solving and innovation. Studies emphasise the role of robotics in promoting learning and creative expression, in supporting personalised education, and safe scenario-based learning. Most studies have found that robots as tutors lead to better educational experiences and increased engagement.

Educational robotics can be of great benefit to diverse learners, preparing them for a future education, work and life intertwined with AI and robotics. Diversity and inclusivity are important aspects of educational robotics, especially when it comes to students with special needs (EU Business School, 2022; Purdue University, n.d.).

Despite all the benefits that the introduction of robots in education brings, some challenges have also been identified, such as high costs, logistical issues, the need for innovative teaching methods and the importance of addressing teacher and student concerns for successful robot integration. Teachers' main concerns relate to potential disruption in the classroom, inequitable access, additional workload, and impact on student relationships, which they believe is mainly due to the fact that they have no direct experience with educational robots. There is also the need for teacher training, curriculum development, and the need to

explore and refine the integration of robotics in education, especially in terms of didactics (Mubin et al., 2013; Esteve et al., 2019; Belpaeme & Tanaka, 2021; Bustos Iliescu, 2023).

The challenges mentioned are the reason why most studies and reports (Mubin et al., 2013; Anwar et al., 2019; Esteve et al., 2019; Alnajjar et al., 2021; Gubenko et al., 2021; Chi et al., 2022; Bustos Iliescu, 2023; Wang et al., 2023) advocate for further research, interdisciplinary research, long-term studies, and strategic and diverse implementation of robotics. There is a necessity for building infrastructure, training teachers, and applying innovative research methods to effectively utilise robots, while emphasising a pragmatic approach for their integration. The call for further research refers to considering factors such as educational level and assessment type for effective implementation of robots to a certain level, collaborative learning and customisation of robots to meet student needs, positioning robots as complementary tools rather than replacements for teachers, and developing affordable access strategies, such as shared resources and repurposing older robots or securing government support. The hope is that future research will help to fully exploit the educational potential of AI and robots in education in order to maximise all benefits and enable inclusion.

Some studies have focused on the topic of human-robot interaction, i.e. child-robot interaction. Among them, there are three main issues within the context of children's interactions with social robots. The first is the development and effectiveness of assessment tools for studying children's perceptions and relationships with social robots (Kory-Westlund & Breazeal, 2019). The second issue is the complex, context-dependent relationship between children's emotional responses to social robots and learning outcomes (Chen et al., 2020). Finally, there is the issue of the impact of educational programmes on children's perceptions of and trust in social robots. This is being investigated by DiPaola et al. (n.d.) as part of their project "Impact of Education on Child-Robot Relationships" which reveals that while knowledge about robots increases, trust may decrease, emphasising the need for innovative educational methods. All authors underscore the need for further research and novel educational strategies to effectively navigate the evolving dynamics of interaction between children and robots.

## **Methodology**

The aim of the research was to explore attitudes, opinions and perceptions of adults within the educational system, primarily students and teachers, towards educational robots, including advantages, disadvantages, and potential challenges of introducing robots into the

education system. The purpose was to gain insight into adults' understanding of educational robotics and to map the current use of educational robots.

The main research questions were as follows:

1. What are the attitudes, opinions, and perceptions of adults within the educational system towards educational robots?
2. What are the most commonly perceived advantages, disadvantages, and challenges related to the use of robots in education?
3. What is the state of the art in relation to the use of educational robots?

An online survey was conducted. The questionnaire consisted of 12 questions, was created using Google Forms and distributed in two iterations via e-mail, from the beginning of December 2023 to the end of January 2024. Convenience sampling was used, and the questionnaire was designed to be answered by adults, i.e. students and teachers who are active participants in educational system. A total of 102 respondents took part in this research. The statistical analysis was carried out using MS Excel and descriptive statistics were used to quantitatively describe the data sets.

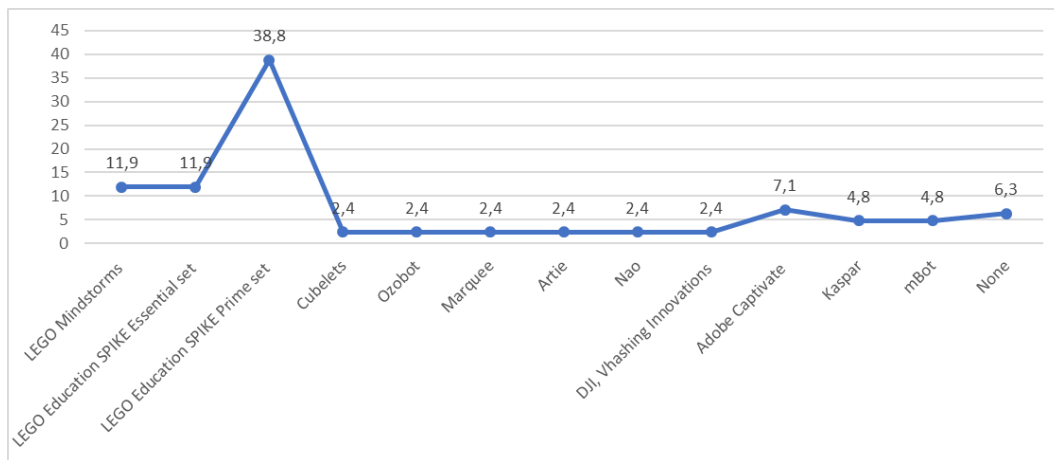
## **Results**

In the study, 102 respondents participated ( $n = 102$ ). Of the 102 respondents, 79 were female (77.5%) and 23 were male (22.5%). 26 respondents (25.5%) fell into the 18-20 age group, 46 respondents (45.1%) into the 21-30 age group, and 30 respondents (29.4%) into the 30+ age group.

In response to the question "Have you encountered educational robots before?" 75 respondents (73.5%) answered "No", while only 27 (26.5%) respondents had previously encountered educational robots.

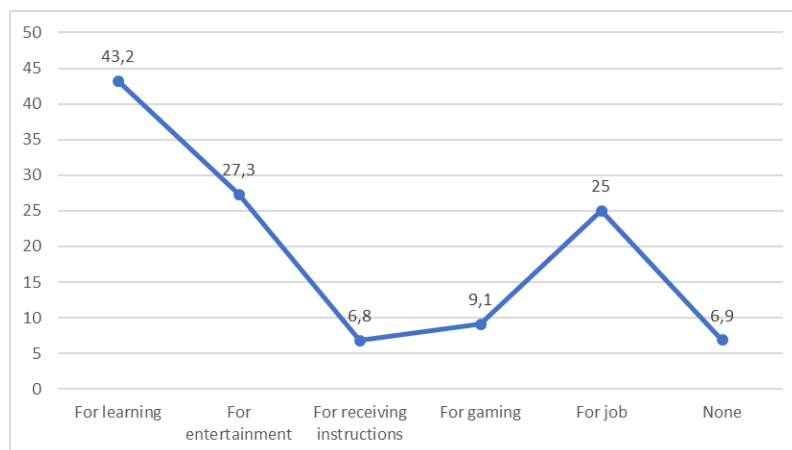
Based on the question "Which educational robots have you used before?" (see Figure 1), where multiple answers were possible, it is evident that LEGO series robots were far more common compared to all other robots. The LEGO Education SPIKE Prime Set was used by 16 (38.8%) respondents, the LEGO Education SPIKE Essential Set and LEGO Mindstorms were each used by 5 (11.9%) respondents, Adobe Captivate was used by 3 (7.1%) respondents, Kaspar robot and mBot were each used by 2 (4.8%) respondents, and Cubelets, Ozobot, Marquee, Artie, and Nao robots were each used by 1 (2.4%) respondent. Adding up the share of LEGO robots, we find that a total of 26 respondents, or 61.9%, used LEGO robots. One user

added that they used robots from the companies DJI, Vhashing Innovations, and FESTO, but since these cases involve filming drones and not educational robots, they are not considered to have used educational robots.



**Figure 1.** The usage of educational robots (%)

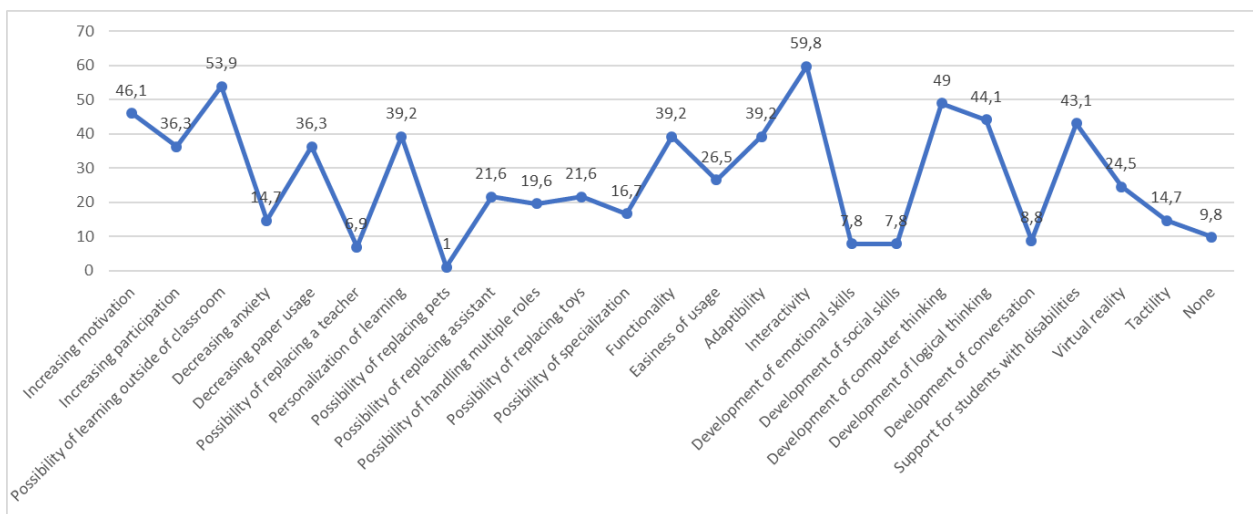
The question “For what purpose have you used educational robots so far?” (see Figure 2), where multiple answers were also possible, revealed that educational robots are primarily used for their intended purpose. 19 (43.2%) respondents stated they used robots for learning, 12 (27.3%) respondents used robots for entertainment, 11 (25%) respondents for work, 4 (9.1%) respondents for gaming, and 3 (6.8%) respondents for receiving instructions.



**Figure 2.** The purpose of usage of educational robots (%)

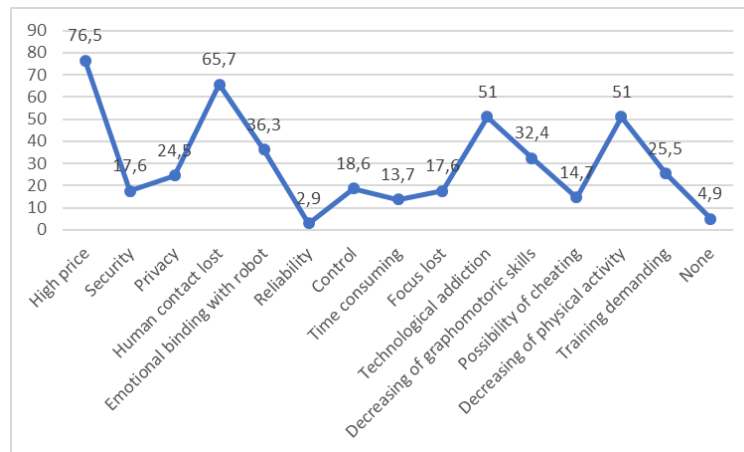
The next question, “Do you own an educational robot?”, shows that educational robots are primarily acquired by legal entities, as 98 (96.1%) respondents answered that they do not own an educational robot, while only 4 (3.9%) respondents stated that they do own an educational robot. The following question, “Do you think educational robots have the following advantages?” (see Figure 3), is the first question that provides insight into the respondents’

opinions about educational robots. The most frequently mentioned advantages were interactivity, chosen by 61 (59.8%) respondents, learning opportunities outside the classroom chosen by 55 (53.9%) respondents, developing computational thinking chosen by 50 (49%) respondents, and increasing motivation chosen by 47 (46.1%) respondents. The least highlighted advantages were the possibility of replacing pets, chosen by 1 (1%) respondent, the possibility of replacing teachers chosen by 7 (6.9%) respondents, developing emotional skills and developing social skills, each advantage chosen by 8 (7.8%) respondents, and the development of conversational skills, chosen by 9 (8.8%) respondents.



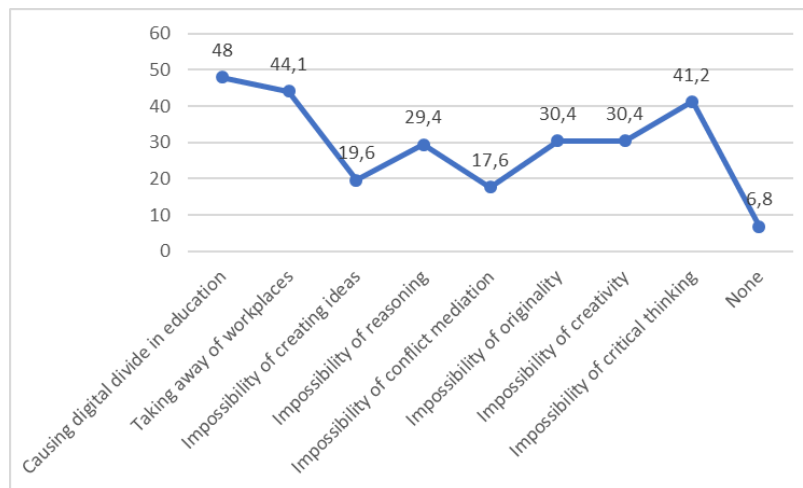
**Figure 3.** The advantages of educational robots (%)

The next question (see Figure 4), in contrast to the previous one, aimed to examine the main disadvantages of educational robots, and was phrased as follows: “Do you think educational robots have the following disadvantages?”. Of the 102 respondents, 78 (76.5%) believe that the price of educational robots is high, 67 (65.7%) respondents highlighted the loss of human contact, which refers back to the previous question where the least highlighted advantages were the development of emotional and social skills and the possibility of replacing teachers. 52 (51%) respondents stated that dependence on technology and reduced physical activity were the biggest disadvantages. On the other hand, the least highlighted disadvantages were accountability, the answer chosen by 3 (2.9%) respondents, time commitment, which was chosen by 14 (13.7%) respondents, the possibility of cheating, which was chosen by 15 (14.7%) respondents, and loss of focus and safety, which was chosen by 18 (17.6%) respondents.



**Figure 4.** The disadvantages of educational robots (%)

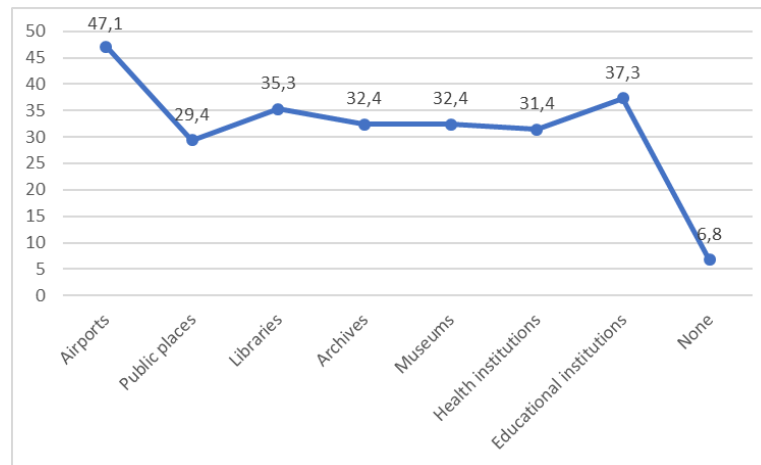
The next question (see Figure 5) was: “In your opinion, what are the most dangerous challenges of educational robots?”. The most dangerous challenge identified was the creation of a digital divide in education due to unequal technology access, chosen by 49 (48%) respondents, followed by job displacement, chosen by 45 (44.1%) respondents, and the inability to think critically, chosen by 42 (41.2%) respondents. The least dangerous challenges identified were the inability to solve complex problems, chosen by 18 (17.6%) respondents, the inability to develop ideas on an issue, chosen by 20 (19.6%) respondents, and the lack of originality and creativity, chosen by 31 (30.4%) respondents.



**Figure 5.** The challenges of educational robots (%)

The following question (see Figure 6) was: “In your opinion, in which sectors of human activity should educational robots be implemented?”. Airports received the most mentions with 48 (47.1%) respondents, while educational institutions came second with 38 (37.3%) mentions. This was followed by libraries with 36 (35.3%) mentions, followed by archives and museums

with 33 (32.4%) mentions each. The lowest number of mentions was for healthcare institutions with 38 (31.4%) mentions and other public institutions with 30 (29.4%) mentions.



**Figure 6.** Implementation of educational robots (%)

The last question was related to the general perception of the development of educational robots in the future, where the offered answers were “positive” and “negative”. 70 (68.6%) respondents answered that they consider the development of educational robots in the future to be positive, while 32 (31.4%) respondents answered that they consider the development of educational robots in the future to be negative.

## Discussion

Despite various studies and reports showing that educational robotics is gaining prominence and being recognised for its potential to enhance learning, particularly in STEM fields (Anwar et al., 2019; Esteve et al., 2019; Belpaeme & Tanaka, 2021; EU Business School, 2022), almost two-thirds of survey respondents stated that they had never encountered educational robotics in any form, suggesting that the integration of this technology in Croatian classrooms is not widespread. Among those who have already had interaction with educational robots, affordability appears to play an important role in their use, with LEGO Mindstorms and LEGO Education SPIKE sets being the most commonly used. This preference underscores the influence of cost on the choice of educational robots; in fact, LEGO products account for about 62% of educational robots in use. This trend can be observed not only in Croatia, but also in other countries embracing educational robots.

The primary motivation for using educational robots is education, followed by entertainment, work, and gaming purposes. It is noteworthy that 96% of respondents do not personally own an educational robot, indicating that they are predominantly purchased by



institutions rather than individuals. This trend could be attributed to the prohibitive cost of educational robots, which poses a barrier for many families or individuals to acquire one. Moreover, educational robots are often purchased by organisations that have the necessary financial resources or receive external support, e.g. through government grants or donations. Institutional ownership and shared, i.e. community use of educational robots facilitates the development of skills beyond what the robots themselves can provide, such as emotional and social competencies, which may not be as effectively nurtured when robots are owned and used by individuals.

Previous studies have indicated that educational robots promote STEM learning and engagement, and they prepare students for future careers, while fostering inclusivity and supporting students with special needs. They point to various benefits of educational robots across learning levels and subjects, including enhancing creativity, critical thinking, and personalised learning experiences, as well as supporting students with disabilities in the learning process (Mubin et al., 2013; Anwar et al., 2019; Alnajjar et al., 2021; Belpaeme & Tanaka, 2021; Gubenko et al., 2021; Chi et al., 2022; EU Business School, 2022; Wang et al., 2023; Purdue University, n.d.; Bustos Iliescu, 2023; Purdue University, n.d.). This assertion was corroborated by the findings of this study, which brings forth a critical perspective on interactivity, cautioning against overreliance on technology that requires little to no thinking, potentially negating the purpose of educational robots as tools for enhancing critical and computational thinking. Respondents' insights into the advantages and disadvantages of educational robots offer valuable perspectives. The primary benefits identified include the enhancement of interactivity, the mobility of learning environments, and the promotion of diverse cognitive approaches. However, the emphasis on interactivity should be approached with caution to ensure it does not diminish the need for critical thinking, which is a crucial element of educational objectives.

Furthermore, providing support for students facing different challenges is a significant advantage of educational robots, offering substantial potential to transform educational support systems. This technological intervention facilitates the delegation of certain instructional tasks to robots, thereby allowing educational rehabilitators and teaching assistants to allocate their attention more effectively across a broader cohort of students with special needs. Consequently, this approach not only enhances the efficiency of educational professionals, but also ensures more individualised and focused support for students requiring additional assistance, suggesting

the potential for state-supported initiatives to make these tools more accessible to such families, thereby facilitating continuous education and skills development at home.

While previous studies have not addressed much the impact of educational robots on the development of social and emotional skills, this study identified a critical concern regarding the potential replacement of teachers and the development of emotional and social skills. Among the less emphasised benefits are the potential of robots to supplement educators and, correspondingly, for them to contribute to the development of emotional and social skills as well as conversational abilities. It is crucial to acknowledge that humans and robots constitute two distinct entities and that robots at present cannot replace humans in many aspects. Contemporary technology has not advanced to a stage where robots can mimic human behaviour and communication closely enough to be considered full substitutes for teachers. Robots lack the capability to teach empathy, manage emotions, foster high-quality social interactions, fulfil the human need for contact, or provide affection, warmth, and genuine support. Nonetheless, robots may offer considerable value in teaching factual knowledge, such as arithmetic or biological concepts, in a straightforward and accessible manner. Beyond the role of the educator, the interaction with peers is vital for the comprehensive development of these competencies, as individuals are most likely to relate to and understand their counterparts that they spend considerable amounts of time with.

Conversely, the significant cost of these robots is a major disadvantage, limiting their accessibility in educational and domestic settings. This has been confirmed by previous studies which acknowledge the issue of high costs associated with educational robots (Mubin et al., 2013; Esteve et al., 2019; Belpaeme & Tanaka, 2021; Bustos Iliescu, 2023). Other concerns include the potential for reduced human interaction, increased dependence on technology, and a decrease in physical activity. Moreover, the risk of exacerbating the digital divide and potential job displacement present challenges that warrant careful consideration. The danger of the digital divide is exponentially increasing in the 21<sup>st</sup> century as it is closely linked to the disappearance of the middle class of the population, while job displacement will become a more significant threat in the future.

As for the least severe challenge, respondents emphasise the concern regarding the educational robots' lack of capacity to solve complex problems. Addressing such problems typically requires the application of diverse methodologies and cognitive strategies to derive viable and effective solutions. Should an educational robot assume a substantial part in interactive or cognitive tasks, thereby enabling students to circumvent the intrinsic challenges

and efforts of problem solving, it becomes implausible to anticipate development of problem-solving abilities of students educated under such circumstances. In essence, reliance on educational robots to this extent may not contribute to the development of greater problem-solving skills compared to current standards.

Both previous and this study acknowledge the challenges of integrating educational robots into learning environments, including logistical issues and the need for innovative teaching methods. However, while previous studies (Mubin et al., 2013; Anwar et al., 2019; Esteve et al., 2019; Alnajjar et al., 2021; Gubenko et al., 2021; Chi et al., 2022; Bustos Iliescu, 2023; Wang et al., 2023) emphasise the need for further research and strategic implementation to maximise benefits and address challenges, the results of this study show greater concern with the loss of human contact, technological dependency, and the risk of a digital divide in education due to unequal technology availability, highlighting more nuanced concerns regarding the socio-economic implications of educational robotics.

## **Conclusion**

In view of the seemingly limitless capacity for innovation and invention, technological progress represents an unpredictable aspect of human existence. Educational robotics emerges as a burgeoning field within this spectrum, evolving rapidly to align with market demands and expectations. These robots vary significantly in complexity, from basic constructions akin to LEGO sets equipped with rudimentary programming capabilities to sophisticated autonomous systems capable of learning and rudimentary decision making, exemplified by models such as Nao, Kaspar, and Yuki. Designed with particular educational domains in mind, such as STEM, educational robots are currently tailored to specific demographics, including elementary school students and children with special needs. This is partly due to the current technological limitations in creating versatile robots suitable across various subjects and age groups, and their consequent high costs, leading to them being primarily purchased by institutions or with the help of government funding.

The integration of educational robots into learning environments offers a whole spectrum of advantages, from enhancing interactive learning to supporting students with challenges. Empirical evidence suggests that educational robots enhance motivation and interest in academic subjects, foster computational and logical reasoning, and reduce anxiety and feelings of insecurity. Conversely, findings also indicate potential drawbacks, such as increased loneliness and diminished emotional, social, and communicative competencies, particularly in scenarios of inadequate engagement from educators or interaction between peers.

These insights underscore the importance of cautious integration of robots in educational settings, advocating for a balanced approach that does not position robots as replacements for human teachers. It is an imperative to navigate the associated disadvantages thoughtfully to maximise the benefits of these technological tools for educational advancement.

Observing the trajectory of educational robotics, it is reasonable to project that this field is still in its nascent stages, with expectations of significant growth and wider application in the foreseeable future. This expansion is anticipated to extend beyond the educational environment and into various sectors. The research presented in this paper reveals a generally positive reception towards the future development of educational robots among students and teachers, alongside an awareness and readiness to strategically incorporate these technologies into the educational process.

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## **Educational Potential Of Major MOOC Platforms**

Ana Mirković Moguš

Faculty of Education, Josip Juraj Strossmayer University of Osijek, Croatia

### **Abstract**

The progress of online learning and the promotion of open educational materials which offer a unique educational opportunity have led to the development of innovative virtual courses known as Massive Open Online Courses (MOOCs). In spite of the widespread and continuous increase in usage of MOOCs, there is still a lack of their comprehensive evaluation. The aim of this paper is to evaluate selected free courses focused on student training on three different platforms based on the existing approaches in the evaluation of MOOCs and to provide a common recommendation for using MOOCs. The analysis included the data collected from online platforms Coursera, EdX and Udacity as well as from Class Central aggregator's database, which offer insights into the MOOCs available on major online platforms. Based on content analysis of articles, reports, official documents related to MOOCs and information obtained from user reviews, common factors that promote the usage the platforms include high-quality course content, flexibility of platforms, diverse course selection and credible instructors. Results offer a detailed insight into how technology can influence student training and its potential to enhance the overall quality of education for students.

*Keywords:* course, enhance, evaluation, learning, support

### **Introduction**

Massive Open Online Courses (MOOCs) are digital classes created to cater to a large audience worldwide. These virtual courses can be attended by individuals with internet access, providing a broad and diverse learning opportunity. MOOCs offer valuable distance learning opportunities for both professionals seeking career development and students across various educational levels (Gonçalves & Gonçalves, 2023). MOOCs serve as effective tools for enhancing individuals' expertise and competencies through technological means, making them a practical choice for personal or group-based learning experiences. Various educational resources are included in MOOCs, such as video lessons, reading materials, quizzes, and

interactive forums for discussions (Gil Jiménez et al., 2023). This mix of materials accommodates different ways of learning, making the learning process more engaging. The organized curriculum in MOOCs mirrors that of regular academic classes, offering a complete educational experience. MOOCs offer a wide range of subjects, encompassing technical areas such as computer science and the humanities. This variety caters to a diverse set of interests and the need for professional growth. Thousands of Massive Open Online Courses (MOOCs) are accessible globally through diverse entities such as companies, educational institutions - both public and private, and even individual enthusiasts. Gonçalves and Gonçalves (2023) mention Cognitive Class, Coursera, Edx, FutureLearn, Iversity, Khan Academy, Myriad X, Udacity, Udemy, and Saylor as the most known MOOC platforms. According to the Open Education Database (2023), more than 16,500 Massive Open Online Courses (MOOCs) are accessible globally, offered by over 950 educational institutions. These courses cover a range of subjects, totalling more than 20,000 across various platforms. The majority of these educational offerings can be accessed through prominent MOOC providers like Coursera, EdX, and Udacity. A lot of Massive Open Online Courses (MOOCs) provide certificates after finishing the course, some of which are free, but for others, it is necessary to pay for verification. These credentials are essential for professionals who want to show proof of what they have learned and the skills they have gained. Enhanced by collaborations with prestigious universities and educational institutions, MOOCs support rigorous academic quality standards.

In contrast to conventional online classes, Massive Open Online Courses (MOOCs) frequently prioritize interactive learning. Features like peer evaluations, online discussions, and team assignments encourage cooperation and active participation in the learning process. A key benefit of MOOCs is their flexibility, enabling students to study whenever they choose and to advance at their preferred speed, thereby catering to different lifestyles effectively.

### **Importance of MOOCs**

Massive Open Online Courses (MOOCs) have reshaped the educational environment by providing easily accessible learning opportunities to millions of users globally for more than a decade. There is a steady increase in popularity of MOOCs, which are also adapting to fulfil the evolving needs of learners and various sectors. The year 2023 saw an unprecedented surge in student enrolment on MOOC platforms, surpassing 100 million participants on different websites (Class Central, 2024). Originally designed for college courses, these platforms now serve a broader audience, including professionals looking to acquire job-specific skills. Popular

subjects like computer science, data analytics, business, and healthcare are increasingly sought after, indicating a trend towards practical learning.

The educational model of MOOCs has revolutionized access to learning by making it cost-effective, eliminating geographical constraints, and facilitating learning anytime, anywhere. Prospective learners now have the freedom to enrol in courses worldwide without the need to commute to a physical campus. Additionally, they have the flexibility to study at their convenience. The affordability of MOOCs is due to reduced operational costs and the benefits of large-scale operations. The unprecedented technological advancements during the COVID-19 crisis have further bolstered online learning platforms, ensuring uninterrupted education (Goundar, 2023). This shift represents a fundamental change in the way education is delivered, indicating a permanent shift towards virtual learning. While the primary objective of a Massive Open Online Course (MOOC) is to enhance student learning, a recent literature review revealed that they are also utilized for research endeavours aimed at enhancing conventional education methods and learning approaches (Zhu et al., 2022). Hence, the question of how effective they are arises.

### **Studies on evaluating MOOCs**

There are various studies on evaluating specific MOOC courses. Baran et al. (2016) conducted a comparative analysis of various courses related to signal processing and digital communication that they had developed over the years. Another research by Pertuz and Torres (2016) focused on the efficacy of Massive Open Online Courses (MOOCs) in enhancing the academic performance of undergraduate students in a standard Digital Signal Processing (DSP) course. Additionally, publication of Stuchlíková et al. (2014) deepens into a discourse regarding the pros and cons of MOOC programs in the field of microelectronics. Notably, a study of Alhazzani (2020) offers a comprehensive examination of the impact of MOOCs on higher education in Saudi Arabia, emphasizing significant changes within the university system and its outcomes. Furthermore, recent research of Yu et al. (2022) identifies eight key factors that directly influence the effectiveness and outcomes of MOOCs globally, including behavioural intention, engagement in learning, student motivation, perceptions, satisfaction, performance, self-regulation, and social networks. Kasch et al. (2021) examined 50 MOOCs to find effective ways of providing formative feedback and interaction to large student groups. Various methods like quizzes, peer feedback, and simulations were noted as effective tools. Most MOOCs allow interaction between students and course content. The study suggests improving interaction and feedback mechanisms to enhance the quality of online education. Overall, main features of a



successful MOOC refer to content of high quality topics of relevance which are up to date with proper explanation as well as representation.

The majority of students enrol in Massive Open Online Courses (MOOCs) for several key reasons: to overcome personal challenges, acquire qualifications, expand their knowledge in a specific field of interest, and out of curiosity towards MOOCs (Gil Jiménez et al., 2023). Research data relating to the initial 16 EdX MOOCs offered by Harvard and MIT, reveal a notable dropout rate of 50% within the first week (Zhong et al., 2016, Zulkifli et al., 2020). The demographic trend shows that a significant portion of these students are male, with a median age of 24 years. The reasons for dropping out include external pressures such as life circumstances, as well as internal factors. Furthermore, the likelihood of students discontinuing their participation is closely linked to the quality of the MOOCs, the complexity of the course content in relation to the students' study level, and the absence of direct personal support provided to the learners. So, to maintain quality, improve effectiveness, ensure accountability and enhance learner satisfaction, it is important to evaluate MOOCs. It should be noted that assessing MOOCs poses challenges due to the absence of standardized assessment criteria, low completion rates, diverse instructors, and issues with accessibility (Gonçalves & Gonçalves, 2023).

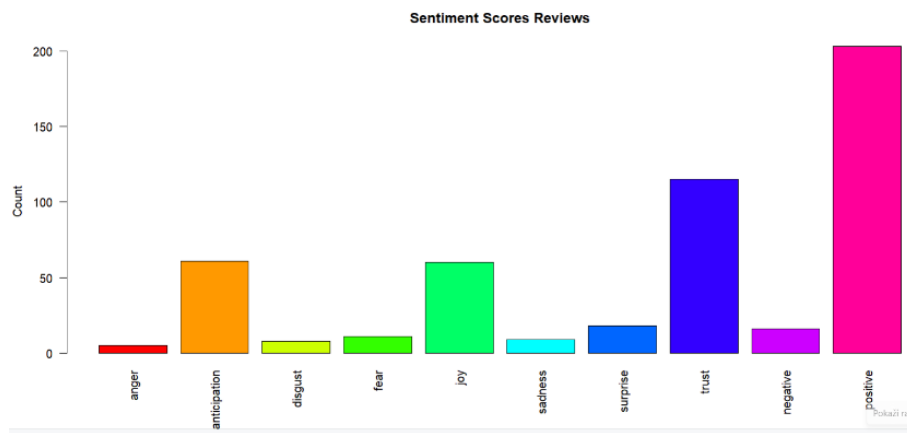
## **Methodology**

The aim of this paper is to evaluate selected free courses focused on student training on three different platforms based on the existing approaches in the evaluation of MOOCs. Three major MOOC platforms were examined: Coursera, EdX and Udacity. From each platform ten free courses focused on computer literacy and data analysis topics were selected. For each course user reviews were collected from MOOCs' website itself where there are often showcase reviews and ratings for their courses. Considering different features of each course in terms of its duration and number of participants, qualitative analysis of individual courses is provided. Also, user reviews of Coursera, EdX and Udacity courses on various platforms such as Trustpilot and Class Central database were collected as well as a database of quantitative data from the same sources. These platforms typically have a wide range of opinions and experiences shared by learners who have taken courses on the aforementioned MOOC platforms. For each MOOC platform, one hundred most recent reviews were exported in a CSV format. The data in the CSV format were loaded into R, prepared for analysis and the package *syuzhet* was run for determining sentiment scores and emotion classification. Sentiment analysis involves identifying and categorizing opinions into different sentiments such as positive, negative, or

neutral (Naseem et al., 2021). By analysing sentiments, one can determine the overall tone or feelings conveyed in a piece of text. It is a classification technique that assigns data to various categories, such as positive, negative, happy, sad, angry, and more, based on the sentiments expressed within the text.

**Results**

Considering the overall results for the aforementioned platforms, sentiment score is high in the category positive, followed by trust, anticipation, and joy for all three platforms. An analysis example of a platform is shown in Figure 1. Similar results are obtained for other two platforms, while the share of negative emotions is a bit higher only on one platform.



**Figure 1** Sentiment analysis of reviews – example of Coursera

Furthermore, a qualitative analysis of individual courses was conducted by classifying user reviews in groups of positive, negative and neutral. A visual representation of the frequency of words was used by using a bar chart applied to each group which were summarized in a table format (Table 1). Analysis of user reviews of some courses are further presented.

**Table 1** Most frequent words in user reviews

Group	Words	Frequency
Course / Content	course, content, program, project, clarity, variety, accessibility, adaptability experience, personalized	127
Flexible platform	learning experience, interactivity, support, feedback	60
Instructor	mentor, instructor, communication skills, engaging lectures	36

First reviews related to the course of computational thinking show that the course received a diverse range of feedback, with many learners finding it helpful and informative, while others encountered challenges, especially in the later weeks when Python programming was introduced. It is common for courses to have areas where improvement is needed, whether it is in pace, instruction clarity, or learner support. Emphasized strengths were related to clear explanation of computational thinking concepts, engaging lectures and interesting case studies, helpfulness for beginners in computer science, provision of a good foundation for learning Python and programming, as well as well-structured course content. On the other hand, areas for improvement were related to the fact that the transition to Python programming in the later weeks could be smoother, with more support for learners who are new to coding. Some learners found the assignments challenging, especially if they lacked prior experience in Python. The autograder and peer review systems could be improved to provide more accurate feedback. Clarification and additional examples could enhance understanding, especially in complex topics.

The second example includes reviews of the course related to cloud computing. It seems like opinions on this course are quite varied. Some learners found the course to be informative, well-structured, and beneficial for gaining fundamental understanding of cloud computing concepts. They appreciated the opportunity to learn from industry experts and found the hands-on exercises valuable for practical experience. However, others expressed frustration with various aspects of the course. Some mentioned issues with the peer grading system, difficulties with account creation or accessing course materials, and concerns about the quality of certain videos or the pace of instruction. Additionally, there were comments about the heavy promotion of IBM Cloud services throughout the course, which some learners felt detracted from the learning experience.

The next course related to data analysis using Microsoft Excel revealed some positive feedback as well as areas for improvement. The positive feedback involves appreciated hands-on learning, especially by visual/hands-on learners. The instructor received high praise for clear communication and teaching pace. The course was described as insightful and helpful for beginners. Some learners found the course to be a great refresher on Excel skills. The guided project was seen as a good introduction to data analysis. The course format and content were praised for being concise and easy to understand. Many learners expressed gratitude for the opportunity to learn and develop new skills. The areas for improvement reflected frustration with the user interface by some learners, particularly the split screen and program/platform interruptions. Issues with accessing data files and certificates were mentioned. Suggestions

were made for more practical assessments and additional sample exercises. Some learners desired more complex projects or topics for further learning. Technical issues with the course platform were mentioned, such as screen resizing problems. Concerns were raised about the lack of personalization in certificates. A desire for more practice assignments and opportunities for independent learning was also expressed. Overall, it seems like the course has been beneficial to many learners, but there are some areas where improvements could be made to enhance the learning experience.

## **Discussion**

Students often enrol in MOOCs with diverse motivations. Some seek out these courses to acquire specific knowledge or skills, while others do so to further enrich their existing expertise. Additionally, individuals may join MOOCs out of a sense of curiosity about particular subjects or simply for personal enrichment. Regardless of their motivations, MOOCs cater to external participants and must be thoughtfully structured. Some user reviews stated concerns about the quality of certain videos or the pace of instruction. To improve this, a combination of instructional videos, interactive quizzes, and engaging activities is crucial for three primary objectives: knowledge dissemination, diverse learning experiences, and ensuring student engagement (Gil Jiménez et al., 2023). Given that participation in MOOCs is typically voluntary, maintaining high levels of engagement is essential. Poor choices in video content or activities can significantly impact student participation, undermining the overall learning experience (Guo et al., 2014). MOOCs offer a key benefit in their ability to reach a large audience, as students can engage with course materials from any part of the world and at their convenience (Mutawa, 2023). Additionally, MOOCs provide learners with the opportunity to learn from a diverse range of experts and professionals globally, enhancing the overall learning experience. But only well-designed and effectively delivered MOOC courses can manage to blend classroom boundaries with wider spaces and social concerns through a vibrant learning community (Nurutdinova et al., 2023).

In particular, analysis of the course related to computational thinking revealed that it seems like the course has valuable content but may need some adjustments to better accommodate learners with varying levels of experience and to improve the assessment and support mechanisms. Considering other courses, it appears that, while many learners found the courses to be helpful and informative, there are areas where improvements could be made to enhance the overall learning experience.

General observations regarding online learning platforms show variation in quality where substantial variations can be observed among different providers and courses. Typically, the reputation of the institution plays a significant role in determining the quality of the content offered. While individual courses are often available free of charge, additional fees may apply if one decides to pursue a series of courses or requires certification. Research shows that interacting with peers can offer valuable support (Loh et al., 2024). While mainstream classes typically have active discussion forums, more specialized courses may see less engagement in these forums. Utilizing social media for communication and quick feedback allows educators to tailor learning experiences to each student, better equipping them for real-world challenges (Brereton & Young, 2022). Occasionally, courses may have an extended timeline that surpasses the actual time needed for completion. Hence, even the courses planned for four weeks could potentially be finished in just a few days. The majority of classes available on Coursera, EdX, and Udacity are conducted in English. Yet, comprehension may be a challenge with certain lectures delivered by international educators for which providing written transcripts for reference would be beneficial. Also, there is a need to expand the user support system to additional elements other than the standard FAQ.

## **Conclusion**

The significance of MOOCs in education increases daily. The emergence of MOOCs implies a significant change in the educational field. These online courses provide a range of learning options that are adaptable, convenient, and varied. MOOCs enable individuals to engage in continuous learning and are simultaneously key in enhancing career growth in different industries. With the advancement of technology, MOOCs are playing an essential part in forging ahead with the direction of education, ensuring that it reaches a broader and more diverse global community. Positive features dominate in major MOOCs while common factors that promote the usage of the platforms include high-quality course content, flexibility of platforms with an adequate user support system, diverse course selection and credible instructors. The limitations of the study are that it only evaluates a selected number of free courses on three specific platforms and does not consider paid courses or other platforms offering MOOCs. The study does not include a longitudinal analysis to track the long-term impact of MOOCs on student learning and career outcomes. Future research should include a wider range of platforms and both free and paid courses to provide a more comprehensive evaluation of MOOCs. In addition, it is necessary to design longitudinal studies to track the long-term impact of MOOCs on students' academic and career outcomes. Compared to other

research, this study evaluates multiple platforms, uses aggregated data sources as well as content analysis of varied sources. Evaluation of MOOCs based on user reviews can provide useful insight into its educational effectiveness, and hence can be used as an approach in the selection of an appropriate platform as well as the course according to users' needs.

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## **The Effectiveness of Math Computer Games in Promoting Student Engagement and Achievement**

Damir Tomić, Vjekoslav Galzina and Diana Moslavac Bičvić

Faculty of Education, University of Osijek, Croatia

### **Abstract**

Modern education is increasingly shaped by information technology, aligning with the knowledge-based progress of contemporary society. Learning is most effective when it involves multiple perceptual experiences enabled by multimedia teaching. Math computer games can help students develop positive attitudes towards math and facilitate the acquisition of abstract thinking, logical conclusions, and precise formulation of phenomena, which are important skills for success in math and other subjects. The purpose of this study was to determine the level of influence of math computer games that meet the pedagogical criteria in classes on the learning of students regarding different age, gender, as well as teaching and learning strategies. Students in the 4<sup>th</sup> grade of elementary school (students of younger school age, average age of 10), students in the 8<sup>th</sup> grade of elementary school (students of older school age, average age of 14), and 4<sup>th</sup> grade high school students (average age of 18) participated in the study. The study incorporated a testing methodology involving initial and final assessments. Results show that using math computer games positively affects learning outcomes for students of all ages, regardless of age or gender. A blended approach, which combines traditional teaching methods with math computer games, has proved to be especially effective for students who have difficulty learning using only traditional methods.

*Keywords:* game-based learning, math computer games, mathematics education, learning outcomes, blended approach

### **Author's Note**

This study was part of a doctoral dissertation. No funding was required for conducting this research.



## **Introduction**

Modern education is increasingly shaped by information technology, aligning with the knowledge-based progress of contemporary society. One of its core objectives is to cultivate individuals who can access information sources and apply them effectively in various situations, fostering lifelong learning and decision-making skills. Learning is most effective when it involves multiple perceptual experiences, enabled by multimedia teaching. With the rise of digital tools in classrooms over the past 20 years, math education is being re-evaluated, highlighting the need to shift from isolated approaches to integrated, interdisciplinary, and holistic methods (Jukić Matić et al., 2023). Research by Lister (2015) emphasizes the benefits of computer games, such as increased enthusiasm, motivation, better knowledge application, and easier concept assimilation in daily life.

As our educational landscape evolves, computer games should be integrated into modern teaching and learning strategies to engage digitally literate students who thrive on rapid interactions and inductive reasoning. Prensky (2001) underlines the digital immersion of today's youth, urging educators to adapt to their needs. Holzinger et al. (2005) and Ahn et al. (2012) point out that computer games support emotional learning, problem-solving, and creativity, fostering the development of competent and confident individuals. This makes computer games an excellent motivator for learning across various subjects. Despite their rising popularity, the effectiveness of math computer games in improving student math performance requires further research (Tokac et al., 2019). In this context, math computer games have gained prominence, especially with their wide availability on the Internet. It is essential to explore how these games, grounded in learning theory, influence different age groups, logical abilities, motivation, and the acquisition of mathematical content when compared to traditional teaching methods.

## **Aim and hypotheses of the research**

The aim of the research was to determine the level of influence of math computer games that meet the pedagogical criteria in classes on the learning of students of different ages and with regard to gender, but also concerning teaching and learning strategies whereby learning is either traditional, using only games, or using a blended approach. Accordingly, the scientific hypotheses of the study were set:

H1) Application of math computer games in teaching mathematics has a more positive effect on the achievement of learning outcomes in younger students compared to older students.

H2) There is no statistically significant difference in learning outcomes between boys and girls in using math computer games in class.

H3) Blended approach to learning with the help of computer games gives better results in terms of achieving learning outcomes than strategies taught only traditionally or only using games.

## **Methodology**

In the conducted research, there were three groups of students of different ages: students in the 4<sup>th</sup> grade of elementary school (students of younger school age, average age of 10), students in the 8<sup>th</sup> grade of elementary school (students of older school age, average age of 14) and 4<sup>th</sup> grade high school students (average age of 18). The research was conducted in the Elementary school Ivan Goran Kovačić and in the High school A. G. Matoš in Đakovo.

The selection of educational computer games for research was guided by specific criteria:

- User interface and age-appropriateness: Games must have an intuitive and age-appropriate graphic interface to engage and educate students effectively (Gee, 2003; Klawe, 1998; Rosas et al., 2003; Vanisri & Roslina, 2015).
- Compatibility with educational framework: Games should correspond to educational goals and tasks, integrating well with existing educational frameworks (Roach, 2003; Moreno, 2002; Loderer et al., 2020; Karakus et al., 2008).
- Clear goals and rules: Games should have clear, comprehensive instructions and well-defined objectives (Hurd & Jennings, 2009; Malone & Lepper, 1987; Çankaya & Karamete, 2009).
- Support for cognitive abilities and intelligence: Games should enhance students' cognitive abilities and intelligence, making learning enjoyable (Sedig, 2007; Ke & Grabowski, 2007).
- Fostering creativity and competitive spirit: Games should promote creativity and a sense of competition among students (Vlachopoulos & Makri, 2017; Malone & Lepper, 1987; Huang Wen-Hao et al., 2010; Shaffer, 2006; Ke & Grabowski, 2007).
- Multimedia content: Effective games incorporate multimedia elements such as animations, music, special effects, and visually appealing graphics to enhance engagement (Gee, 2003; Klawe, 1998; Papadimitriou, 2020; Mann, 2008).

- **Interactivity:** Interactivity is crucial, with games providing feedback and opportunities for active participation (Klawe, 1998; Moreno, 2002).

These criteria ensure that educational computer games meet pedagogical standards and effectively contribute to the learning process (Tomić, 2022).

According to the given criteria, the following games were selected for this research:

(1) 4<sup>th</sup> grade elementary school – Math Puzzle:

**Game description:** In this single-player game, students manipulate numbers arranged in a 4x4 grid with arithmetic operation symbols. They are given a target number and must choose the correct numbers and operation symbols to reach the target.

**Educational focus:** The game helps 4<sup>th</sup> grade students practice basic arithmetic operations (addition, subtraction, multiplication, and division), aligning with the national curriculum.

(2) 8<sup>th</sup> grade elementary school – Games Wheel:

**Game description:** In this single-player game, students can select different math areas (numbers, algebra, geometry, etc.). Each area offers various games. For example, in the “numbers” section, students act as postmen solving mathematical problems and delivering letters.

**Educational focus:** Students practice percentages, proportionality, geometry, and measurement, aligning with the 8<sup>th</sup> grade math curriculum.

(3) 4<sup>th</sup> grade high school – Tombstone Timeout:

**Game description:** This multiplayer game features questions from various math areas. Players compete to answer correctly and can track each other’s progress in the same room.

**Educational focus:** 4<sup>th</sup> grade high school students practice advanced topics like factoring polynomials, complex numbers, and trigonometric functions, aligning with the national curriculum for high school mathematics.

These games were chosen based on their alignment with educational goals and their potential to support students in developing math skills.

The research incorporated a testing methodology involving initial and final assessments, adhering to standardized procedures (Bujas, 1981; Mejovšek, 2008). The tests included a series of tasks and served to evaluate abilities and knowledge within the context of specific educational objectives. Notably, tests are considered the most effective measuring instrument in social sciences and humanities (Mejovšek, 2008).

The focus of the knowledge tests was on areas aligned with the national curriculum, varying for different grade levels. For the 4<sup>th</sup> grade elementary students, this included practicing

basic arithmetic operations and understanding geometric shapes. For the 8<sup>th</sup> grade students, it encompassed percentages, proportionality, geometry, and measurement. For the 4<sup>th</sup> grade high school students, the emphasis was on more advanced topics like polynomials, logarithms, and trigonometric functions.

The tests were graded using a scale of marks from 1 to 5, with a maximum score of 20. The sample included three groups: experimental group A and control groups B and C, each comprising 90 respondents, equally divided by gender. Experimental group A consisted of subgroups representing different grade levels. Control groups B and C also had subgroups following the same distribution. Parental consent was obtained following privacy protection regulations, and all respondents were informed of their involvement in the research. Initial testing was conducted to establish the baseline knowledge of all groups. Subsequently, repetition of mathematical content was facilitated by math teachers through teaching and learning strategy (1) – a combination of traditional teaching methods and playing selected computer games (experimental group A), teaching strategy (2) – using solely traditional teaching methods (control group B), and learning strategy (3) – by playing selected computer games (control group C). Final test was conducted to assess the impact of these different approaches to knowledge retention and improvement.

The research design followed an initial-final testing intergroup experimental plan to evaluate the influence of the independent variable of the experimental group in comparison to the control groups. Statistical analyses were conducted, including analysis of variance (ANOVA) for repeated measures, Levene's test, Box M test, and non-parametric Spearman's rank correlation, using the statistical software package STATISTICA (Bland & Altman, 1995). The chosen level of statistical significance was  $p < 0.05$  (5%) for declaring statistically significant differences (Bland & Altman, 1995). This research design helped assess the effectiveness of integrating computer games into the educational process and their impact on students' knowledge retention and progress.

## **Results and discussion**

Table 1 shows descriptive statistics of points for initial and final testing according to gender, strategy, and age. In Table 2 and Figure 1 (A and B), 2, 3 and 4, a statistical analysis (analysis of variance [ANOVA] for repeated measurements) of the comparison of the change in results between the two tests (initial and final) according to gender, strategy, age and their interactions is presented. In Table 3, analysis of homogeneity of variance according to Leven is presented.

In Table 1 and 2 and Figure 4, it is evident that a statistically significant difference was found (better result in girls) in the average test result regarding gender ( $F=3.91$ ;  $p=0.0492$ ), but not for the interaction between initial and final tests regarding gender ( $F=0.06$ ;  $p=0.8124$ ). Table 1 and 2 and Figure 2 show that a statistically significantly better result was obtained in the final test than in the initial one ( $F=514.01$ ;  $p=0.0000$ ).

*Table 1. Descriptive statistics of points for initial and final tests according to gender, strategy, age, and their interactions.*

VARIABLES and INTERACTIONS	Var_1	Var_2	Var_3	N	AS1	SD1	-95% CI1	+95% CI1	AS2	SD2	-95% CI1	+95% CI1
<b>In total</b>				270	12.2	3.33	11.8	12.6	14.0	3.18	13.6	14.4
<b>Gender</b>	F			128	12.6	3.15	12.1	13.2	14.4	3.06	13.8	14.9
<b>Gender</b>	M			142	11.8	3.44	11.2	12.3	13.6	3.26	13.1	14.2
<b>Strategy</b>	1			90	12.1	3.33	11.4	12.8	14.6	3.10	14.0	15.3
<b>Strategy</b>	2			90	12.3	3.26	11.6	12.9	13.7	3.06	13.0	14.3
<b>Strategy</b>	3			90	12.2	3.43	11.5	12.9	13.6	3.32	12.9	14.3
<b>Grade</b>	4			90	12.6	3.25	11.9	13.3	14.3	3.23	13.7	15.0
<b>Grade</b>	8			90	11.6	3.29	11.0	12.3	13.7	3.07	13.0	14.3
<b>Grade</b>	12			90	12.3	3.41	11.6	13.0	13.9	3.25	13.2	14.6
<b>Gender*Strategy</b>	F	1		38	12.8	3.13	11.7	13.8	15.1	2.93	14.1	16.0
<b>Gender*Strategy</b>	F	2		48	12.7	3.15	11.8	13.6	14.1	3.04	13.2	15.0
<b>Gender*Strategy</b>	F	3		42	12.5	3.24	11.4	13.5	14.0	3.15	13.1	15.0
<b>Gender*Strategy</b>	M	1		52	11.6	3.42	10.6	12.5	14.3	3.21	13.4	15.2
<b>Gender*Strategy</b>	M	2		42	11.7	3.34	10.7	12.8	13.2	3.05	12.3	14.2
<b>Gender*Strategy</b>	M	3		48	12.0	3.61	11.0	13.1	13.3	3.44	12.3	14.3
<b>Gender*Grade</b>	F	4		41	12.4	3.22	11.4	13.4	14.2	3.30	13.2	15.3
<b>Gender*Grade</b>	F	8		38	12.3	2.68	11.4	13.2	14.2	2.73	13.3	15.1
<b>Gender*Grade</b>	F	12		49	13.1	3.43	12.1	14.1	14.6	3.14	13.7	15.5
<b>Gender*Grade</b>	M	4		49	12.8	3.30	11.8	13.7	14.4	3.20	13.5	15.4
<b>Gender*Grade</b>	M	8		52	11.2	3.61	10.1	12.2	13.3	3.26	12.4	14.2
<b>Gender*Grade</b>	M	12		41	11.3	3.16	10.3	12.3	13.1	3.24	12.1	14.1
<b>Strategy*Grade</b>	1	4		30	12.7	3.14	11.6	13.9	15.4	3.07	14.3	16.6

VARIABLES and INTERACTIONS	Var_1	Var_2	Var_3	N	AS1	SD1	-95% CI1	+95% CI1	AS2	SD2	-95% CI1	+95% CI1
Strategy*Grade	1	8		30	11.6	3.26	10.4	12.9	14.4	2.74	13.4	15.5
Strategy*Grade	1	12		30	11.8	3.59	10.5	13.2	14.0	3.39	12.8	15.3
Strategy*Grade	2	4		30	12.2	3.22	11.0	13.4	13.6	3.23	12.4	14.8
Strategy*Grade	2	8		30	11.8	3.23	10.6	13.0	13.5	3.08	12.3	14.6
Strategy*Grade	2	12		30	12.8	3.34	11.6	14.0	13.9	2.95	12.8	15.0
Strategy*Grade	3	4		30	12.9	3.46	11.6	14.2	14.0	3.19	12.8	15.2
Strategy*Grade	3	8		30	11.5	3.46	10.2	12.8	13.1	3.31	11.9	14.4
Strategy*Grade	3	12		30	12.2	3.34	11.0	13.5	13.8	3.50	12.5	15.1
Gender*Strategy*Class	F	1	4	13	12.5	2.93	10.7	14.2	15.1	2.99	13.3	16.9
Gender*Strategy*Grade	F	1	8	11	13.4	2.98	11.4	15.4	15.7	2.61	14.0	17.5
Gender*Strategy*Grade	F	1	12	14	12.6	3.57	10.5	14.6	14.5	3.20	12.6	16.4
Gender*Strategy*Grade	F	2	4	12	11.5	3.40	9.3	13.7	13.1	3.80	10.7	15.5
Gender*Strategy*Grade	F	2	8	17	12.4	2.60	11.1	13.7	14.0	2.57	12.7	15.3
Gender*Strategy*Grade	F	2	12	19	13.7	3.26	12.2	15.3	14.8	2.88	13.4	16.2
Gender*Strategy*Grade	F	3	4	16	13.0	3.35	11.2	14.8	14.4	3.10	12.7	16.0
Gender*Strategy*Grade	F	3	8	10	11.0	2.11	9.5	12.5	12.9	2.56	11.1	14.7
Gender*Strategy*Grade	F	3	12	16	12.8	3.60	10.9	14.7	14.4	3.54	12.6	16.3
Gender*Strategy*Grade	M	1	4	17	12.9	3.36	11.2	14.7	15.7	3.20	14.1	17.3
Gender*Strategy*Grade	M	1	8	19	10.6	3.06	9.2	12.1	13.7	2.58	12.4	14.9
Gender*Strategy*Grade	M	1	12	16	11.2	3.60	9.3	13.1	13.6	3.59	11.7	15.5
Gender*Strategy*Grade	M	2	4	18	12.7	3.11	11.1	14.2	14.0	2.85	12.6	15.4
Gender*Strategy*Grade	M	2	8	13	10.9	3.86	8.6	13.3	12.8	3.63	10.6	15.0
Gender*Strategy*Grade	M	2	12	11	11.2	2.93	9.2	13.1	12.5	2.54	10.7	14.2
Gender*Strategy*Grade	M	3	4	14	12.8	3.70	10.6	14.9	13.5	3.35	11.6	15.4
Gender*Strategy*Grade	M	3	8	20	11.8	3.99	9.9	13.7	13.3	3.68	11.5	15.0
Gender*Strategy*Grade	M	3	12	14	11.6	3.01	9.8	13.3	13.1	3.43	11.1	15.1

**Table 2.** Statistical analysis (ANOVA for repeated measurements) of comparison of changes in results between two tests (initial and final) according to gender, strategies, age and their interactions.

EFFECT	SS	df	MS	F	p
Interception	88223.77	1	88223.77	4394.08	0.0000
<b>Gender</b>	<b>78.42</b>	<b>1</b>	<b>78.42</b>	<b>3.91</b>	<b>0.0492</b>
Strategy	45.37	2	22.69	1.13	0.3247
Grade	45.22	2	22.61	1.13	0.3259
Gender*Strategy	8.18	2	4.09	0.20	0.8158
Gender*Grade	90.83	2	45.42	2.26	0.1063
Strategy*Grade	37.26	4	9.31	0.46	0.7622
Gender*Strategy*Grade	89.17	4	22.29	1.11	0.3522
Error	5059.63	252	20.08		
<b>Initial/final</b>	<b>420.24</b>	<b>1</b>	<b>420.24</b>	<b>514.01</b>	<b>0.0000</b>
Initial/final*Gender	0.05	1	0.05	0.06	0.8124
Initial/final*Strategy	<b>34.40</b>	<b>2</b>	<b>17.20</b>	<b>21.04</b>	<b>0.0000</b>
Initial/final*Grade	3.67	2	1.83	2.24	0.1082
Initial/final*Gender*Strategy	4.04	2	2.02	2.47	0.0868
Initial/final*Gender*Grade	1.40	2	0.70	0.86	0.4260
Initial/final*Strategy*Grade	4.44	4	1.11	1.36	0.2494
Initial/final*Gender*Strategy*Grade	0.26	4	0.06	0.08	0.9889
Error	206.03	252	0.82		

In Table 1 and 2 as well as in Figure 3, it is visible that the greatest statistically significant ( $F=21.04$ ;  $0.0000$ ) progress in the results between initial and final tests was achieved in implementing teaching and learning strategy (1), while for teaching strategy (2) and learning strategy (3), there was no difference in progress between initial and final tests. No statistically significant difference was found for the other variables and their interactions ( $p>0.05$ ).

**Table 3.** Homogeneous variance analysis according to Levene

	MS - Effect	MS - Error	F	p
<b>Initial testing</b>	2.3204	3.1479	0.7371	0.7632
<b>Final testing</b>	2.1140	2.9242	0.7229	0.7783

In Table 3, it is evident that the homogeneity of the variances was determined and that the analysis of variance is a suitable test used to analyse the test results and the influence of independent variables (gender, age, learning and teaching strategies, and their interactions (Box M=69.485;  $\chi^2=65.52$ ; df =51; p=0.0830).

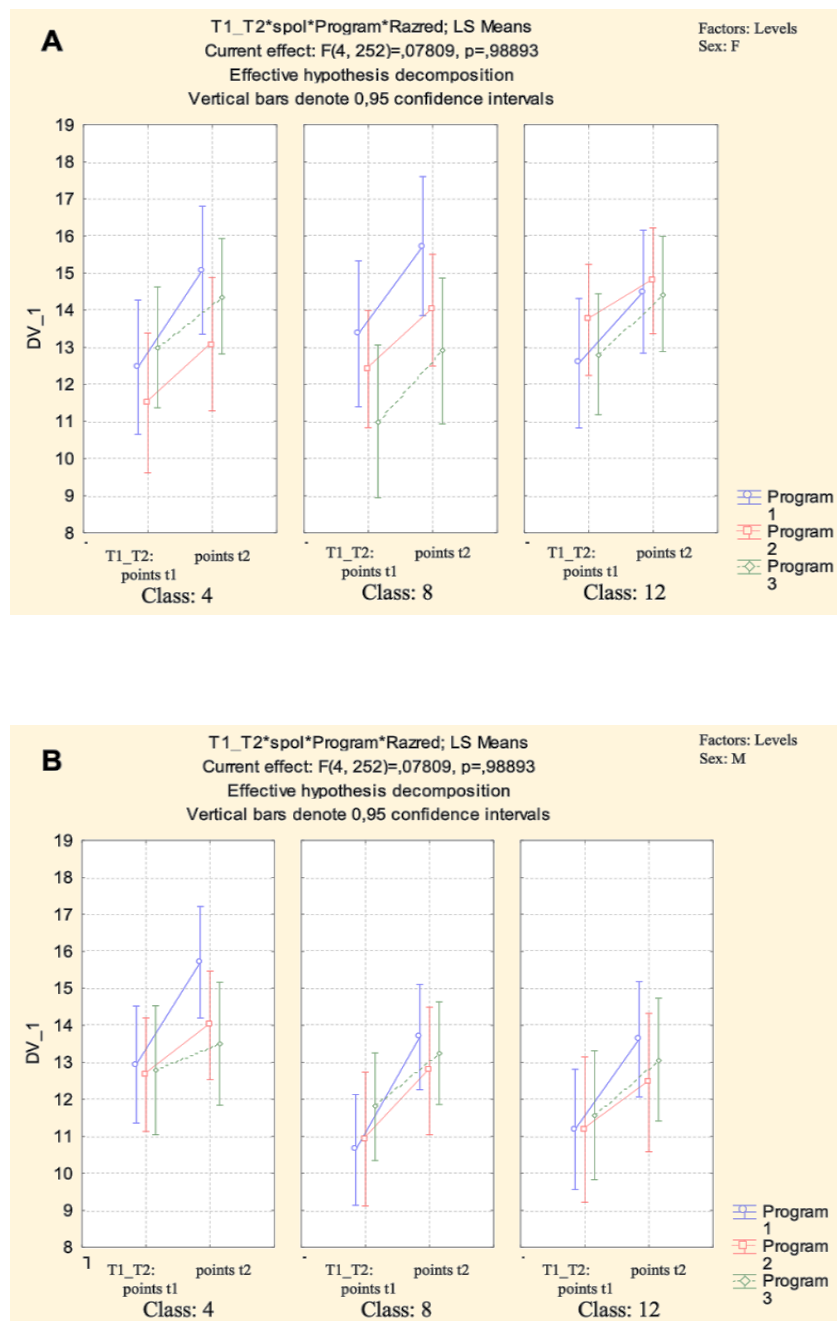


Figure 1.<sup>6</sup> Presentation of the comparison of the change in results between the two tests (initial and final) according to gender (A – female; B – male), strategies, age, and their interactions.

<sup>6</sup> In Figures 1, 3, and 4, program stands for strategy, class for grade, and sex for gender.



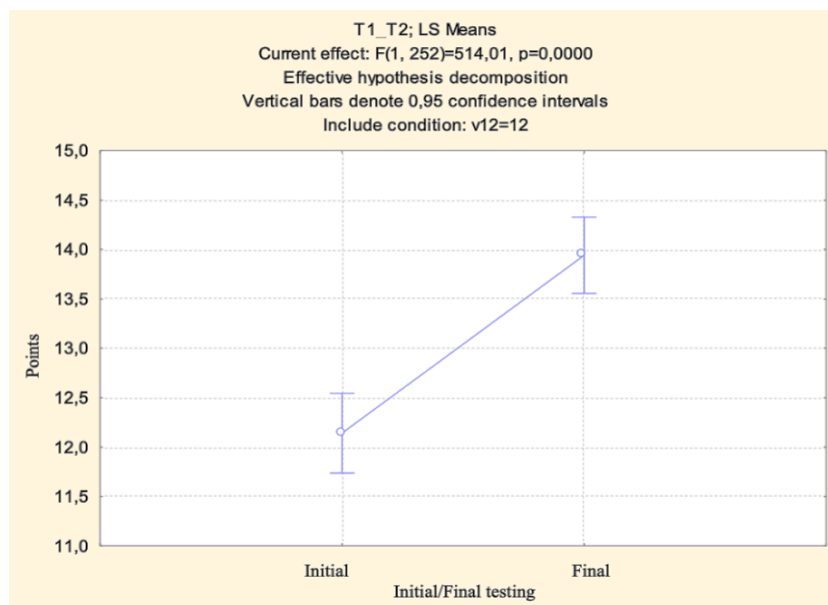


Figure 2. Display of the comparison of the change in results between two tests (initial and final).

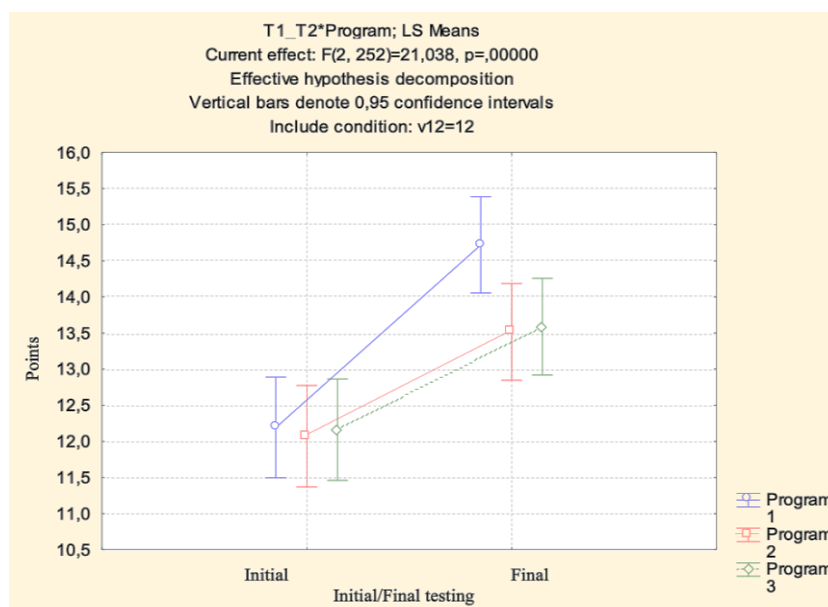
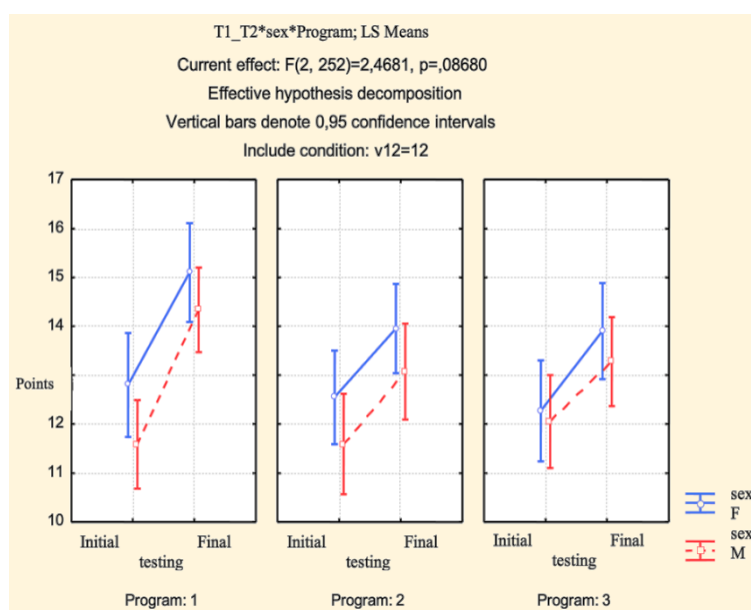


Figure 3. Presentation of the comparison of the change in results between two tests (initial and final) according to teaching and learning strategies.



**Figure 4.** Comparison of the change in results between two tests (initial and final) according to gender and learning and teaching strategies.

Table 4. shows the results of the initial and final tests according to marks from 1 to 5.

**Table 4.** The results of the initial and final testing presented as marks (1-5).

Grade	Mark	Strategy 1		Strategy 2		Strategy 3	
		Initial	Final	Initial	Final	Initial	Final
4 <sup>th</sup> grade elementary school	1	4 (13.3)	1 (3.3)	7 (23.3)	3 (10)	6 (20)	2 (6.7)
	2	11 (36.7)	4 (13.3)	7 (23.3)	8 (26.7)	8 (26.7)	10 (33.3)
	3	9 (30)	11 (36.7)	13 (43.3)	9 (30)	8 (26.7)	7 (23.3)
	4	5 (16.7)	8 (26.7)	3 (10)	8 (26.7)	8 (26.7)	10 (33.3)
	5	1 (3.3)	6 (20)	0 (0)	2 (6.7)	0 (0)	1 (3.3)
8 <sup>th</sup> grade elementary school	1	9 (30)	1 (3.3)	7 (23.3)	4 (13.3)	10 (33.3)	5 (16.7)
	2	8 (26.7)	7 (23.3)	10 (33.3)	9 (30)	8 (26.7)	8 (26.7)
	3	9 (30)	10 (33.3)	10 (33.3)	5 (16.7)	7 (23.3)	10 (33.3)
	4	4 (13.3)	10 (33.3)	3 (10)	11 (36.7)	5 (16.7)	6 (20)
	5	0 (0)	2 (6.7)	0 (0)	1 (3.3)	0 (0)	1 (3.3)
4 <sup>th</sup> grade high school	1	8 (26.7)	3 (10)	6 (20)	3 (10)	8 (26.7)	5 (16.7)
	2	6 (20)	7 (23.3)	8 (26.7)	6 (20)	6 (20)	7 (23.3)
	3	11 (36.7)	9 (30)	9 (30)	7 (23.3)	11 (36.7)	6 (20)
	4	5 (16.7)	8 (26.7)	6 (20)	14 (46.7)	5 (16.7)	8 (26.7)
	5	0 (0)	3 (10)	1 (3.3)	0 (0)	0 (0)	4 (13.3)

## **Comparison of results with previous research**

The conducted empirical research led to several significant conclusions:

Effect of mathematical computer games across age groups: The research revealed that the application of math computer games in teaching math has a uniform effect across different age groups. In other words, the differences in learning outcomes between students of various age groups were not statistically significant. This finding is consistent with prior research by Van Eck (2006), Cameron & Dwyer (2005), Lim et al. (2006), and Karakus et al. (2008), which have shown that computer games promote learning among students of various ages.

Effect of mathematical computer games across gender: The research found no statistically significant difference in learning outcomes between genders after using math computer games in teaching math. It aligns with studies such as Yang & Chen (2010) and Papastergiou (2009), which have demonstrated that math computer games have a positive impact on learning for both boys and girls.

Effectiveness of blended learning: A blended approach to teaching math that combines traditional teaching methods with the integration of math computer games was found to yield better results in terms of achieving learning outcomes compared to either exclusively traditional teaching or solely using computer games. This finding is consistent with previous research, including studies by Papastergiou (2009), Din & Calao (2000), Rosas et al. (2003), Ke & Grabowski (2007), and Harter & Heng-Yu (2008), which have emphasized the effectiveness of a blended approach in improving students' knowledge.

To summarize, this research underscores the potential of math computer games as effective tools for improving teaching math, highlighting their applicability across different age groups and genders. Furthermore, it emphasizes the importance of blended learning strategies that combine traditional teaching with educational games to achieve optimal learning outcomes. The results are consistent with prior studies in the field, consolidating the case for incorporating math computer games into teaching math.

## **Conclusion**

Based on the research findings, the use of math computer games in teaching math enhances the achievement of educational objectives at all educational levels. Math games, grounded in learning theory, positively impact students of different ages, fostering the development of their logical abilities, problem-solving skills, abstract thinking, logical reasoning, and precise formulation of mathematical concepts. Math computer games also play a crucial role in shaping students' attitudes towards mathematics. They help create a positive

perception of a subject that students often find challenging, enhance motivation, and facilitate faster and more lasting knowledge acquisition compared to traditional methods.

This research empirically demonstrated that the influence of math computer games transcends age, with no significant differences in learning outcomes among students of different age groups. It also showed that math computer games have a uniform effect on both genders, corroborating previous research findings.

A blended approach in math teaching strategies, incorporating math computer games alongside traditional teaching methods, proves most effective in achieving improved learning outcomes. Solely relying on computer games or traditional methods produced similar, albeit weaker results, highlighting the need for innovative interventions in traditional math teaching.

In conclusion, the research confirms that math computer games have a positive impact on students of all age groups, with no significant differences between age categories. Implementing math computer games as part of the teaching process offers several advantages, including enhanced memorization, student engagement, and alignment with educational goals, all while catering to the preferences of modern, tech-savvy students. The design of such games should prioritize clear educational objectives, user-friendliness, multimedia elements, interactivity, and age-appropriate content. By harnessing modern technology and adapting to students' needs and abilities, well-designed math computer games provide a more efficient and engaging approach to education for students of all ages.

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## **The contribution of complementary digital content in teaching Science and Social Studies**

Tena Rak<sup>1</sup>, Edita Borić<sup>2</sup> and Tomislav Malenica<sup>1</sup>

<sup>1</sup>PhD student, Faculty of Education, University of Osijek, Croatia

<sup>2</sup>Faculty of Education, University of Osijek, Croatia

### **Abstract**

The rapid advancement of information and communications technology (ICT) has resulted in its integration into the educational process, leading to changes in teaching methodologies and approaches. In addition to digital textbooks, which are electronic versions of printed textbooks, teachers and learners now have access to a wide range of other digital resources to enhance learning and grasp educational content conceptually. ICT has been used in the conceptual learning of scientific content by supplying various tools for creating materials that include not only text and images but also other multimedia elements like sound, video, animation, simulation, 3D renderings, and more.

This study aims to investigate the most common types of digital content among complementary digital resources associated with Science and Social Studies textbooks from three publishers, Školska knjiga, Profil Klett, and Alfa for the 1st and 4th grades of primary school. The research purpose is to determine whether complementary digital content contributes to a better comprehension of the subject matter in Science and Social Studies, specifically in terms of conceptual learning. A qualitative approach was employed to analyse the textbook content and corresponding digital content. The examination of complementary digital content revealed that visual content, particularly photographs and illustrations, is predominant. Moreover, digital textbooks hold a substantial amount of video content. Textbooks from all three publishers show a prominent level of interactivity, with Profil Klett leading in this area.

ICT contributes to constructive learning of scientific content, while the findings indicate the importance of digital literacy for teachers. Teaching supplemented with complementary digital content is more engaging and challenging for students.

*Keywords:* complementary digital content, Science and Social Studies, conceptual learning, interactive multimedia content

## **Introduction**

In the age of rapid digitalization, information and communications technology (hereinafter referred to as ICT) has found its place in various aspects of human life and work, including education. Using ICT, students acquire digital competencies that enable lifelong learning (Bulić, 2018).

Regarding textbooks as the most valuable tool for teaching and learning, it is evident that printed textbooks have certain limitations in accurately depicting processes that are either spatially or temporally distant to students. On the other hand, digital textbooks can incorporate various multimedia elements such as audio, video, animations, 3D renderings (Nuli, 2018), simulations, interactive maps, games, quizzes, and more.

Information and communications technology assist students in achieving the necessary learning outcomes and therefore should be integrated into the educational process (Bulić, 2018). Teachers who are information and computer-literate create a wide range of teaching scenarios and incorporate modern ICT tools in the teaching process (Bulić, 2018). The traditional role of teachers as the primary source of knowledge has changed (Lukša et al., 2016); teaching is student-centered, where learners independently and actively construct their knowledge.

A variety of digital teaching materials go with digital textbooks, ranging from photographs and illustrations found in traditional textbooks to 3D models, videos, audio recordings, simulations, animations, educational games, and quizzes. Multimedia digital textbooks are characterized by their interactivity, students solve tasks as they meet them in the content processing with immediate feedback and the ability to monitor their progress. Multimedia digital textbooks complement rather than replace printed textbooks because the conditions in education and society have not yet been created for their replacement (Nuli, 2018).

The investigation into the presence and scope of complementary digital content in Science and Social Studies textbooks will involve the analysis of six textbooks sanctioned by the Ministry of Science and Education [MSE], which are among the most selected for the school year 2023/2024 (MSE, 2023a).

The first part of the study will outline the theoretical framework surrounding this issue, focusing on the needs of modern teaching for the inclusion of various multimedia content that through its interactivity motivates students to learn and develop competencies. The second part of the study will delve into data processing, specifically focusing on the examination of textbook content and associated complementary digital content, to count their presence and evaluate the level of interactivity they offer. In the third part of the study, the results of content analysis show that visual representations, namely photographs and illustrations, are the most



abundant and that the level of interactivity is high. Through the provided context, an attempt was made to emphasize the significance of complementary digital content in addressing the demands of modern society.

### **Theoretical approach to the issue**

The teaching of the 21st century, particularly in the field of science and technology, is characterized by the use of innovative pedagogical approaches designed to actively engage students in scientific and technological activities (Alt, 2018). In the educational environment, technology becomes a tool that enriches and enables various learning experiences. However, to effectively harness the benefits of information and communications technology, teachers must be digital literate. According to The National Curriculum for primary education (2018), with the help of information and communications technology, teachers can creatively and innovatively supplement traditional teaching methods, dynamically realise, monitor, and evaluate the teaching process, and tailor the approach for each student.

When it comes to learning and teaching the subject of Science and Social Studies and its concepts, the attainment of expected learning outcomes relies on a variety of materials and sources of knowledge (Curriculum for the subject of Science and Social Studies for primary schools, 2023c). Primarily, the source is the real world, utilized whenever possible. The contents of the subject Science and Social Studies mostly surround the students and are part of their close reality, so experiential learning, learning in nature, is very important. Additional teaching material is the textbook, which conveys information through written text and visual aids. However, for phenomena and concepts that are abstract, invisible to the naked eye, or inaccessible, complementary digital content accompanying the textbooks is employed. It remains important to present the teaching content to the students in a clear way. Complementary digital content in addition to textbooks of Science and Social Studies enable the display of these remote contents through images, videos, audio recordings, simulations, games. Verbal and visual content in science textbooks can lead to the creation of misconceptions, and they further negatively affect the success of students and make it impossible to learn accurate information (Kara, Aktürkoğlu, 2019). Textbooks often contain insufficient information, therefore digital content that enriches the teaching content plays a big role. According to the research conducted by Bišćan (2021) on classroom teachers about the application of ICT in Science and Social Studies, teachers use ICT in order to keep students' attention more easily, to motivate them and to make it easier for students to adopt teaching content.

Digital educational content refers to content recorded in digital format and used for educational purposes. The choice of appropriate digital content depends on the subject and activities, with the aim of greater student engagement (Lazić, 2023).

There are four domains in each class in the subject Science and Social Studies in the Curriculum for the subject of Science and Social Studies for primary schools (MSE, 2023c): Organization of the world around us, Changes and relationships, Individual and society, Energy. Each domain has a certain number of outcomes that students in that grade should adopt. In the Curriculum, all outcomes are described in detail, as well as recommendations for achieving educational outcomes. In each domain of the Curriculum, there are recommendations for using ICT in many different ways: showing something (e.g. days of the week, life cycle of a plant, water cycle in nature), playing online games, making works (e.g. traffic signs, timelines), presentation of events or persons (e.g. famous people), in discussions (e.g. addiction to computer games), use of Google tools (e.g. Google Maps when learning terrain, roads, appearance of villages or cities), computer simulations (e.g. energy conversion). All types of additional digital content can be used in all stages of the lesson. It mostly depends on the teacher how will the lesson be organized.

Kostović-Vranješ et al. (2019) highlight the significance of the teacher's digital competence and the school's material resources in determining the successful implementation of ICT. Conducted research (Lukša et al., 2014; Kostović-Vranješ et al., 2015; Bulić, Novoselić, 2016) has indicated that teachers often do not fully utilize ICT in their teaching practices due to inadequate school equipment and insufficient training, which can be traced back to their university education (Kostović Vranješ, Tomić, 2014; Gudmundsdottir, Hatlevik, 2017). Moreover, the lack of Croatian language materials has been cited as a barrier to the effective integration of ICT in teaching (Lukša et al., 2014), although this situation has improved over time. Recent research (Borsos et al., 2020; Bišćan, 2021; Kuduz, 2021) shows that teachers now use ICT regularly in their teaching practices and consider it beneficial, despite some schools still facing challenges related to inadequate equipment. It is essential to provide teachers with lifelong professional development opportunities (Kovačić, Čović, 2021) because the low level of teachers' computer literacy results in a low level of ICT application in teaching, also shown by the research on biology teachers conducted by Kostović Vranješ, Bulić, Novoselić (2015). The professional development of teachers in ICT can positively affect an increase in ICT activities in constructivist-oriented teaching.

Multimediality is a key characteristic of digital materials because it brings educational content closer to students, involving multiple senses in the learning process (Kuduz, 2021),

which contributes to the correct understanding of scientific concepts and makes teaching more interesting. According to research conducted by Winarso et al. (2023), the implementation of interactive multimedia content improves students' conceptual understanding, increases their engagement in the learning process while reducing misconceptions. The authors emphasize that interactive multimedia tools and content effectively aid students in overcoming existing misconceptions. By using interactive multimedia, students can actively engage in learning, explore concepts and receive appropriate feedback to correct their understanding. Winarso et al. (2023) say that convincing visual representations allow students to better understand the concepts taught. Conceptual learning will be more significant and lasting when more experiences related to concepts are offered, thus it is necessary to include various interactive multimedia content to support learning (Kara & Aktürkoğlu, 2019). The advantage of interactive multimedia lies in its ability to present information visually, audibly, and interactively, thereby helping students' comprehension and visualization of complex concepts. As concluded by Winarso et al. (2023), teachers should integrate interactive multimedia into their daily teaching practices to aid students in understanding intricate concepts. The goal of modern education is to include as many human senses as possible in learning (Kuduz, 2021). In this way, it is possible to experience things that are not possible with pictures and text alone. A printed textbook is not enough for today's student. Additionally, digital textbooks are important for stimulating students' curiosity (Herianto & Wilujeng, 2020). Unlike traditional printed textbooks, interactive quiz questions can satisfy students' curiosity, thereby increasing motivation for work. Conceptual learning encourages understanding rather than memorization. Also, conceptual learning makes it possible to upgrade knowledge, that is, it implies reliance on existing connections in memory. It is very important in Science and Social Studies because that subject is characterized by a multitude of concepts that students create from an early age, since they begin to explore the nature around them. Different visual representations encourage students to learn concepts rather than individual pieces of information.

A scientifically literate student should own critical thinking skills, interpret complex data, and solve problem tasks, all of which are achievable today through e-learning based on concepts such as self-learning, active learning, independent learning, and encompasses problem-solving, simulations, and practical work (Bulić, 2018).

The purpose of this study is to analyse textbooks and their complementary digital content to decide which type is the most abundant. It also aims to investigate whether there are any variations in the abundance of complementary digital content based on the publisher and school grade. Finally, the analysis examines to what extent textbooks facilitate interactivity,

and to name the textbook and publisher that offer the most favourable learning conditions. To conduct this research, six textbooks were chosen, consisting of three textbooks for the 1st grade and three textbooks for the 4th grade for the subjects of Science and Social Studies from three leading publishers in Croatia, Školska knjiga, Profil Klett, and Alfa.

### **Methodological framework of the research**

In line with the set goal, to investigate the problem the content analysis was used, while the results are presented in tabular form in the continuation of the paper. According to Milas (2005), the method of content analysis involves the procedure of sampling materials, deciding units of analysis, determining content categories and units of content, coding, and lastly analysis. Content analysis is characterized by objectivity in following clear and prescribed rules, systematicity in extracting materials in the analysis, and generality reflected in the theoretical significance of the results that surpass the mere description of content (Milas, 2005). The researchers used these characteristics, which they recognised as important for the obtainment of a favoured perspective, to employ the method of content analysis.

The analysis of complementary digital content accompanying textbooks was conducted on three textbooks for the subject of Science and Social Studies for 1st grade and three textbooks for the subject of Science and Social Studies for 4th grade from the three most prominent Croatian publishers, based on The list of selected textbooks for primary school for the school year 2023/2024 (MSE, 2023b), Školska knjiga, Profil Klett, and Alfa, a total of six textbooks approved by the Catalogue of approved textbooks for primary school (MSE, 2023a). Analysed textbooks, i.e., the complementary digital content accompanying textbooks, are as follows from the publisher Školska knjiga titled *Istražujemo naš svijet 1* [Exploring Our World 1] (Letina, Kisovar Ivanda & De Zan, 2023) and *Istražujemo naš svijet 4* [Exploring Our World 4] (Kisovar Ivanda, Letina & Braičić, 2023), textbooks from the publisher Profil Klett titled *Pogled u svijet 1, Tragom prirode i društva* [A Glimpse into the World 1, Tracing Science and Social Studies] (Škreblin, Svoboda Arnautov, Basta, 2023) and *Pogled u svijet 4, Tragom prirode i društva 1. i 2. dio* [A Glimpse into the World 4, Tracing Science and Social Studies 1st and 2nd Part] (Svoboda Arnautov, Basta, Škreblin, Jelić Kolar, 2023a; 2023b), and textbooks from the publisher Alfa titled *Priroda, društvo i ja 1* [Science, Society, and Me 1] (Bulić, Kralj, Križanić, Hlad, Kovač, Kosorčić, 2019) and *Priroda, društvo i ja 4* [Science, Society, and Me 4] (Štambak, Šarlija, Mamić, Kralj, Bulić, 2021) were analyzed. The 1st and 4th grade textbooks were selected because 1st grade textbooks are mostly illustrated, and adapted for students who may be completely digitally illiterate, while 4th grade textbooks contain more

text, more complex teaching content, and can and should contain more complex and demanding tasks as students are already somewhat digitally literate.

The complementary digital content from the publisher Školska knjiga is available on the e-sfera platform, accessible by scanning the code for each lesson. Digital educational content from the publisher Profil Klett is available on the IZZI platform, accessed by scanning the code on first pages of the textbook. The digital version of the textbook from the publisher Alfa with all accompanying complementary digital content is accessed through the mozaBook application, which needs to be installed on a computer, then the desired textbook needs to be added and unlocked with the code provided on the first pages of the printed textbook or via the mozaWeb portal.

Content analysis was conducted as follows: after determining the textbooks that meet the specified criteria for analysis, i.e., units of analysis, categories were defined according to which the content would be analysed. Units of content are types of digital content whose prevalence will be decided according to the binary principle as *existing* or *non-existing*, depending on whether the textbook contains the described type of digital content. For each complementary digital content, a type is decided, and all types are shown in Table 1. Since some complementary digital content types were not significant for the analysis, only the types highlighted in bold style are considered during counting.

*Table 1. List of types of complementary digital content observed through analysis*

<b>photograph</b>	<b>simulation</b>
<b>illustration</b>	<b>game</b>
<b>photo / illustrations gallery</b>	<b>quiz</b>
<b>video</b>	<b>riddle (brief questions, rebus, trivia)</b>
<b>video lesson</b>	<b>picture story, song (literary genre)</b>
<b>audio recording</b>	<b>research task / assignment</b>
<b>3D rendering</b>	<b>link</b>
<b>animation</b>	<b>word or pdf document</b>
<b>animated video</b>	lesson plan
<b>graph</b>	presentation
<b>table</b>	board plan
<b>geographic map</b>	

After opting for the types of complementary digital content, the analysis units were checked, namely, textbooks with corresponding complementary digital content, to see if the

mentioned types were present and by which they were classified on the binary principle into *existing* or *non-existing* categories. Subsequently, one researcher categorized the data extracted from the content into classifications and assessed their prevalence subjectively, followed by replication of the process by the other two researchers. After the individual content-coding, a consensus regarding the final analysis was attained. Whenever a specific kind of complementary digital content was encountered, researchers would mark it with a "+", while for the absence of it, they would mark it with a "-". The total of the "+" symbols constitutes the result, which is presented in Table 2 in the Results and Discussion section.

The primary hurdle in conducting the study lay in identifying the content units, i.e., in classifying complementary digital content, given that each publisher has its method of presenting certain content. For instance, in the textbook *Priroda, društvo i ja 1* [Nature, Society and Me 1] (Bulić, Kralj, Križanić, Hlad, Kovač, Kosorčić, 2019) published by Alfa, numerous informational pages appear as presentations with a solitary slide, containing a photograph or an illustration with questions. The purpose of this content is to provide complementary stimulation alongside the textbook content. Nevertheless, what exactly is this content - a presentation, a photograph, or a quiz? Researchers categorized this content based on its function in the textbook.

## Results and Discussion

The results obtained through the quantitative method of content analysis are presented in Table 2. The numerical value next to each type of digital content indicates how many times that type appeared in a specific textbook, i.e., in the complementary digital content accompanying the textbook.

*Table 2 Results of content analysis of selected textbooks*

	Školska knjiga		Profil Klett		Alfa	
	1 <sup>st</sup> grade	4 <sup>th</sup> grade	1 <sup>st</sup> grade	4 <sup>th</sup> grade	1 <sup>st</sup> grade	4 <sup>th</sup> grade
photograph	13	-	79	184	29	5
illustration	44	-	13	30	16	3
<b>VISUAL CONTENT</b>	57	0	92	214	45	8
photo/illustrations gallery	37	-	49	41	9	17
video	-	<b>128</b>	53	28	2	55
video lesson	-	-	25	20	52	53

audio recording	13	-	12	2	4	-
3D render	-	-	-	-	-	<b>62</b>
animation	1	-	-	-	-	-
animated video / PowToon	4	11	11	-	2	5
<b>VIDEO + ANIMATION + ANIMATED VIDEO</b>	5	139	64	28	4	60
simulation	-	-	-	-	-	-
game	96	28	68	50	22	82
quiz	50	70	68	92	91	68
riddle	-	-	55	43	8	
<b>QUIZ, GAME, RIDDLE</b>	146	98	191	185	121	150
picture story	9	-	6	-	-	-
research task / assignment	-	14	15	34	4	28
link	-	<b>40</b>	-	-	-	-
Word / PDF	1	-	2	3	25	11
presentation	65	61	24	34	38	63
graph	-	-	-	2	-	-
table	-	-	-	1	-	-
geographic map	-	-	-	23	-	9
<b>SUM</b>	373	312	480	587	298	461
<b>sum for each publisher</b>		685		1067		759

Regarding the question of which type of digital content is the most abundant, data presented in the table shows that it is the visual content such as photographs and illustrations, along with photo galleries containing an average of five photographs each. These visual materials specify and elucidate the teaching content, facilitating conceptual learning (Liu & Khine, 2015). According to Ostojić (2011), visual information in textbooks can help students' motivation and focus, as they often convey information on their own. Additionally, there is an equal distribution of quizzes, some of which consist of only one question. The number of

quizzes can also be combined with the number of Word and PDF documents, as they contain teaching worksheets, quizzes, and tasks. The distinction between these two categories lies in interactivity; the "quiz" category counts interactive quizzes that students answer on digital devices that have real-time feedback, while the "Word/PDF" category contains tasks printed on paper.

Videos give significant contribution to teaching (videos, animations, animated videos), of which the Školska knjiga textbooks have the most, especially the textbook for the 4th grade. However, unlike the Školska knjiga textbooks, Profil Klett and Alfa contain video lessons, which give aid for conducting online classes.

It should be noted that the Alfa publisher stands out as the sole provider of 3D renderings. These renderings are often interactive, further elevating the engagement level of teaching content. Moreover, they are especially important in creating conceptual comprehension.

There are many educational activities such as games, quizzes, and riddles that contribute to the interactive nature of textbooks. When research tasks are added to these activities, it becomes apparent that the quantity of interactive elements is quite substantial, which corresponds with the fourth research question. Profil Klett textbooks offer the highest number of interactive elements, followed by Alfa and then Školska knjiga. The games category includes puzzles, memory games, crossword puzzles, and drawing tasks related to specific topics. Riddles include rebuses, brief questions, rearrangement puzzles, and interesting facts with interactive elements. As indicated in a study by Kuduz (2021), the most used features of digital textbooks are educational games and quizzes.

Interestingly, Profil Klett's textbooks are the only ones to feature graphical and tabular representations in their complementary digital content. Moreover, the textbook for the 4th grade, published by the same company, offers numerous geographic maps that are interactive. In contrast, the 4th grade textbook by the Alfa publisher contains fewer geographic maps. Additionally, none of the textbooks have simulations, but links to external content are only found in Školska knjiga textbooks, particularly in the 4th grade textbook.

Moreover, when examining the differences in the number of complementary digital content based on the publisher, it is evident that Profil Klett takes the lead, followed by Alfa, and then Školska knjiga.

The next question is on the quantity of content that varies depending on the grade level. Profil Klett and Alfa show a similar pattern, with more complementary digital content for the



4th grade primary school textbooks. On the other hand, the 1st grade textbook from Školska knjiga has more complementary digital content than the 4th grade textbook.

It would not be right to single out one publisher as the only one that offers the best learning environment based on this. To make that determination, both textbooks and complementary digital content need to be considered together, and future research could investigate this further.

The results obtained from qualitative analysis imply that complementary digital content accompanying textbooks from three publishers in Croatia is extensive, offering students a wide range of content beyond text and images in textbooks to facilitate learning.

It is very important for teachers to understand the benefits that interactive multimedia content has on the acquisition of scientific concepts. Realistic depiction of reality and experiential teaching contribute to conceptual understanding. This study shows that the additional digital content that publishers offer with their textbooks is numerous, and that teachers can use them even though they may not have the knowledge to create digital content on their own. Pictures and visual representations are the most numerous content that appears, they are a great supplement to the teaching content, often the content speaks for itself. Not all the materials that describe the desired teaching content fit on the pages of the textbook, for that purpose there are complementary digital contents that supplement the content. It is necessary to use more tables, graphs, 3D renderings, simulations, geographical maps in classes. This study can make it easier for teachers when choosing a textbook because it provides a summary on the quantity of complementary digital content by different publishers or textbooks.

## **Conclusion**

Changes in technology lead to changes in teaching methods (Bišćan, 2021); printed textbooks are no longer the primary teaching tool, and digital technology tools and services provide students and teachers with new opportunities. Thanks to the possibilities offered by digital technology, students learn faster and easier, keeping them active and curious.

Complementary digital content that we can find alongside textbooks includes photos, photo galleries, videos, audio recordings, educational interactive games, interactive quizzes, 3D renderings and simulations, and more. Thus, integrating ICT into the teaching of Science and Social Studies has a positive and motivating effect on students further enhancing their scientific literacy.

The research in this paper was conducted to determine which type of digital content is the most prevalent, by analysing six textbooks, three textbooks for the 1st grade and three

textbooks for the 4th grade for the subject of Science and Social Studies from three leading publishers in Croatia. Accordingly, the most prevalent are visual materials, followed by games and quizzes. However, there is always room for improvement, and it is necessary to offer students more graphical and tabular representations and simulations to encourage critical thinking and drawing conclusions.

Ultimately, textbooks supplemented with complementary digital content offer a solid educational base, particularly with a plethora of interactive elements. The importance of this study is that it shows how incorporating complementary digital content alongside traditional textbooks can help enhance understanding of scientific concepts. By using realistic scenarios and hands-on experiences, students are better able to grasp conceptual understanding. The use of complementary digital content is essential as it provides additional information that may not be easily presented in a physical classroom setting. These interactive tools spark curiosity in students thus proving their convenient place in the teaching process.

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## **Digital Humanities in Teaching Literature; Albanian Challenge**

Brikena Smajli

University College, Bedër, Albania

### **Abstract**

Faced with the trend of information technology (IT) and the crisis of human studies, the decline of interest in them and the lack of financial support, Albanian culture and Albanian education appear more challenged, therefore it is encouraged to reconcile or change the ways it is studied and taught. The University study programmes that offer solidly and rigorously only Albanian literature or Albanian linguistics, although the new specialists in this field are urgently needed, are at the same time no longer sufficient to prepare researchers or teachers or to give answers to questions in extensively Albanian studies. The offering of programmes in fields such as humanities which connect IT and artificial intelligence (AI), Digital Intelligence (DI), i.e. Digital Humanities (DH), should be embraced without delay in the study programmes offered by Albanian universities. This article, after examining the situation of the humanities studies in Albanian Universities and through an in-depth analysis of challenges and advantages, comparing the experiences of other universities in Europe, proposes and argues the need for the formation of DH study programs, initially at the master's level in Albanian university studies, to respond as best as possible to the market, but also to enable humanities studies to survive and prosper.

*Keywords:* Digital Humanities, Artificial Intelligence, Albanian, education, literature

### **Introduction**

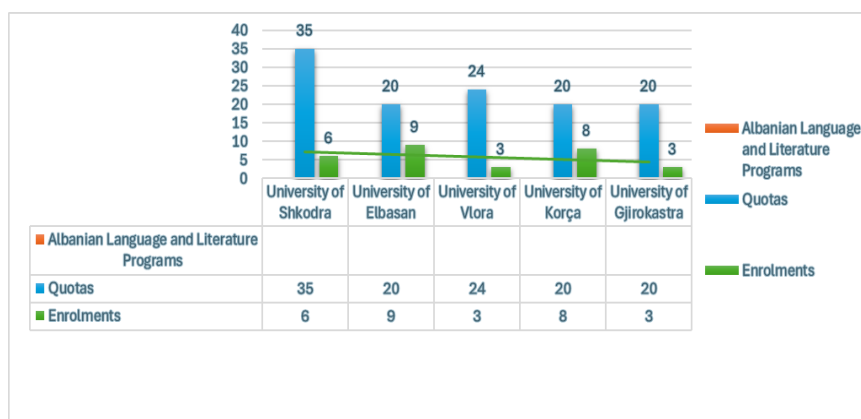
Every year, from mid-February to the end of March, high school seniors in Albania face the task of selecting their university programmes for the upcoming academic year, as per the calendar of the Albanian Ministry of Education and Sports (AMES). As it is discussed in *Liberale* periodical (*Liberale*, 2024) and reported by the AMES (Albania. AMES, 2021, p. 57) reports of latest trends indicate a notable decline in interest in humanities and social sciences programmes, juxtaposed with a growing preference for fields such as computer sciences, information and communication technology, medical sciences, economics, and economic

informatics. A decade ago, teaching programs (excluding mathematics and physics) held sway, however, according to the report of Citizen Resistance 2023 they are now facing endangerment (See Tabaku, 2023, p. 5-9). This decline as per the same report, is particularly stark in foreign language programmes, such as Greek, Turkish, Italian, Spanish, Russian, French, and German, where enrolment numbers may even dwindle to zero, as seen at the University of Elbasan (Tabaku, 2023, p. 7). The reasons behind this trend are multifaceted, stemming from population decline, significant emigration, and challenges in transitioning to the workforce, all of which may discourage prospective students from enrolling in these programmes. Moreover, the educational policies implemented during Albania's transition period have failed to address these issues, instead exacerbating the challenges faced by educators and prospective teachers.

Meanwhile, it is pertinent to highlight the attention given by the AMES and the Decision of the Council of Ministers, No. 386, dated 1<sup>st</sup> June 2022, which approves fields and study programmes deemed as national priorities. This decision includes financial support for outstanding students enrolled in these programs (VKM No. 386, 2022). Notably, within the Arts and Humanities category, the national priority programme encompasses Albanian Language and Literature, offered by only seven public universities across Albania: the universities of Shkodra, Elbasan, Vlora, Korça, Gjirokastra, Tirana, and Durrës. However, these universities, particularly those outside the capital, are increasingly facing challenges in maintaining their programmes. The monitoring report by Citizen Resistance also provides insights into enrolment trends in Albanian language and literature programs, with data from September 2023 (Tabaku, 2023, pp. 5-9).

The following table reflects the data processed according to the report of Gevio Tabaku from Citizens Resistance. It does not include enrolment and quota data for the University of Tirana and the University of Durrës, which do not present this problem.

**Table 1.** Ratio between quotas and enrolments



According to this report, the education system has seen a decrease of 56,000 students over the past two years, further exacerbating the trend of favouring non-humanities disciplines, which are perceived to offer quicker employment opportunities and higher salaries. Despite government policies aimed at prioritizing certain programmes and supporting outstanding students within them, the expected results have not materialized. The Citizen Resistance report (Tabaku, 2023) suggests alternative approaches:

“Universities located outside the city of Tirana should be profiled in order to ensure a balanced distribution of students throughout the country and to avoid study programmes for which interest is low.” (Tabaku, 2023, p. 20)

For the programmes in the field of Arts and Humanities, and especially those of the Albanian Language and Literature, the profiling needs to be examined bearing in mind the application of DH, according to the specifics that the respective universities see that they have traditionally created or in relation with the cultural tradition of the city. Universities thus give their contribution to the preparation of future teachers with innovative skills in the field of digital technology in the teaching of humanities, as well as give their help in preserving, cultivating, and studying a culture like Albanian.

This also addresses the ever-increasing interest of students in technology as well as making IT and AI applicable in Albanian studies. The paper, through an analysis of the opportunities offered by such programs in European universities, examines the advantages offered by the DH programs and proposes their application, not overlooking the problems encountered in their application in the education process and gives answer why in the conditions of a small culture and in crisis like Albanian this should be considered and applied wisely, respecting some specifics of the local culture. Meanwhile, while there is an application of certain methods in teaching technology, IT, AI, a university programme of DH does not exist.

### **Digital Humanities (DH) in the context of teaching and studying Albanian literature**

The proposal for a university study programme in digital humanities (DH) in Albanian universities comes as a response to the global trend of technology development and increased interest in the technological and IT fields, but also from the other side of the systematization and standardization of some digital applications in the humanities in Albania, for which the need is felt more and more to be generalized and widely used and to be part of the competences of humanities teachers, especially language and literature. These programmes offer an innovative approach to the study of humanities using technology and computing to analyse,



interpret, and construct knowledge in fields such as literature, history, art, and culture (see Croxall & Jakacki, 2023, p. 4-6).

The argumentation on the reasons for the DH programme singles out issues as:

- Broad content of the programme: The DH programme finds application in a wide range of studies by integrating technology and computer science with humanities disciplines, in our case, Albanian language and literature. This programme prepares secondary and upper secondary teachers whose, while the education system requires qualified teachers, interest to study and be prepared in these study programs has decreased. Therefore, they are important for attracting students who are interested in technology and computing, but also want to study and work in humanity field studies.
- Increasing students' skills: The DH programme offers opportunities for students to develop knowledge and skills in technology such as data analysis, programming, as well as in the interpretation and understanding of humanities materials, specifically in the Albanian language and literature. This offers students a wide range of careers in the technology and culture sector as well as innovative and interactive teaching with pre-university students.
- Positive impact on the educational ecosystem: The proposal for DH programmes can contribute to diversifying the offer of university programmes in Albania, especially those universities that encounter difficulties in offering traditional programmes, and increase the level of interest and engagement of students in these fields.
- Adaptability to labour market demands: At a time when technology and informatics have a significant impact on the labour market, DH programmes match labour market demands for combined technology and humanities skills. At this point DH serves to reassess the importance of humanities studies (in our case Albanian Language and Literature) in this context.
- Likewise, this affects the growth of Digital skills in Albania especially among the youth, understanding digital skills development, important in facing and aligning with the European labour market and overcoming a gap in relation to EU countries, in relation to these skills (Vuorikari, 2022, p. 70). The current state of the digital skills of the population and the level of digital literacy across the population leave space for improvement, and there are disparities in access to opportunities to acquire these skills. Based on Eurostat data from 2019, only 21% of Albanians between the ages of 16 and 74 possessed basic digital skills, making it one of the lowest rates in Europe (Albania, 2022, p. 51).

In conclusion, considering global trends and the needs of the labour market, the proposal for DH programs in Albania may be advisable to prepare students for the challenges and opportunities of the 21st century in the world of education and work.

### **Traditional programmes of Albanian Language and Literature VS Digital Humanities (DH)**

The advantage and the importance of the application of Digital Humanities programmes are seen only by comparing with traditional programmes of these disciplines. Even in the application of curriculum design, the tradition created by traditional programs is important, in order to build a functional programme connected to the labour market and impactful in society, either with the specialists, professionals, teachers that prepare, or with the methods of the new that he proposes in the study of the humanities.

While the traditional Albanian language and literature programmes still rely on a historicist method of imparting knowledge integrated with research projects (course assignments), the advantage of DH is that it opens new perspectives regarding teaching methods and more concretely integrates scientific research related to the study of the Albanian language and Literature, which affects not only the preparation of future specialists, researchers, and teachers, but also affects the process of teaching Literature in pre-university education. From here, these programmes offer a significant change in the way young people study literature and the Albanian language, using the innovative technology and methodologies that appear because of this.

However, here are the specifically exposed characteristics of such a programme in the context of the most traditional Universities as institutions of higher education in the cities: University of Shkodra "Luigj Gurakuqi" (1957) and University of Elbasan "Aleksandër Xhuvani" (1971) and University of Gjirokastra "Eqrem Çabej" (1971).

*General curriculum:* The programme includes a wide range of subjects in the theory and practice of DH, as well as the study of Albanian literature and linguistics from a digital perspective. This includes subjects such as digital text analysis, data visualization, digital literary projects, etc.

*Focus on the local literary and cultural tradition:* Shkodra is known for the literary and cultural tradition in Albania and in this context, the use of innovative technology and methodology is important to respect and promote the literary and cultural heritage of the city and the region. This includes special courses that examine important authors and texts in Albanian literature, their language, as well as studies on folklore, history, and local culture in a

multidisciplinary approach. The orientation of the programme regarding the literary tradition, language variants and local culture also applies to the University of Elbasan and the University of Gjirokastra.

*Local context and field research:* The programme encourages students to engage in field research and projects related to local cultural and literary context, dialects, and sociolinguistic studies. This includes writing digital projects to document and study local culture, using technology to preserve and promote literary heritage and dialects (see Croxall & Jakacki, 2023, p. 15).

*Use of local resources and collaborative networks:* The programme aims to use local resources and promote collaboration with other cultural and educational institutions to build joint projects and initiatives in the field of DH in literature.

The programme responds to the problem encountered on the decline of interest in the humanities and, specifically, the Albanian language and literature programmes, which through the concretization of the results, the diversification of the disciplinary approaches in the study embodies different points of view and is a promoter of new and innovative ideas in the application of such studies, which are a condition for the preparation of passionate and quality teachers in the subject of Literature.

By incorporating these elements into the development of a DH programme in literature, each university in the respective programme offers a rich and appropriate study experience with the context of the local literary and cultural tradition.

### **Profiling, the case of the University of Shkodra**

Profiling a DH programme at "Luigj Gurakuqi" of Shkodra University, considering the rich literary, cultural, and historical tradition of the city, is an excellent opportunity to strengthen the link between information technology and humanistic studies. Here are suggestions for profiling this programme:

1. Focus on local literary and cultural heritage:

The programme may emphasize the study of the literary and cultural heritage of Shkodra and the surrounding region. This includes text analysis of important Shkodra authors, as well as studies on folklore, art history, folk and local cultural traditions.

2. Resources digitization projects:

Considering the goal of creating a rich data base, the programme may contain projects for the digitization of historical documents, books, newspapers, and other important cultural and historical materials of Shkodra.

3. Visualization of geographical and historical data:

Using digitization and visualization technologies, the programme can present and analyse the geographical and historical data of Shkodra in new and attractive ways. This can include historical maps, time flow visualizations, and other data visualization projects.

4. Teaching and digital education:

The programme could include a strong focus on curriculum development and digital technologies to promote the learning and study of Shkodra literature, history, and culture. This includes digital learning platforms and tools, simulations, teaching projects, and more.

5. Research on society and local history:

The programme may encourage research and projects on various aspects of Shkodra's local history and society, using data analysis and other Digital Humanities methodologies to understand and interpret Shkodra's past and society.

6. Cooperation with institutes and local archives:

Utilizing local resources, the programme can collaborate with cultural institutions and local archives to create joint projects and initiatives that promote the study and protection of Shkodra's cultural and historical heritage.

By integrating these elements into the profiling of the DH program at the University of Shkodra, the university would be able to offer a rich and relevant study experience that matches the city's rich cultural and historical tradition and heritage. This will also help prepare students to use technology and digital methodologies to understand and promote Shkodra culture and history in new and innovative ways.

### **Background: Digital humanities studies in Albania**

Are there DH studies conducted with Albania as the object of study?

There have been studies conducted in the fields of humanities, especially in Language and Literature from the point of view of DH with Albanian culture as the object of study, however, a narrow group of specialists in the field knows about them. These studies include using technology and digital methodologies to understand, analyse and present various aspects of Albanian culture, history, literature, language, and society. The most recently published studies include:

Kabashi, Besim. 2018. "A Lexicon of Albanian for Natural Language Processing." *Lexicographica* 34 (1): 239–48. <https://doi.org/10.1515/lex-2018-340112>.

Kabashi, Besim. 2017. "AlCo – një korpus tekstesh i gjuhës shqipe me njëqind milionë fjalë." *Seminari Ndërkombëtar për Gjuhën, Letërsinë dhe Kulturën Shqiptare*, no. 36: 123–32.

Priku, M., Bushati, J., Sula, A., & Kashahu, L. (2014). "One approach for the role of rhyming dictionaries in developing children's language proficiency and the multimedia technologies." *European Scientific Journal*, 10(14), 24-35.

Edlira Gugu, Ema Kristo. (2023). "Digital Skills of Albanian Lecturers and Students from the Humanities During Pandemic." *US-China Education Review A*, Nov.-Dec. 2023, Vol. 13, No. 6, 307-321.

Smajli, B. (2022, December). "Google Translation, the case of Albanian." *European Journal of Technology and Business (EJTB)*, 1(2), 101 -115. ISSN:2791-3273, ISSN Online: 2791-3273 [www.ejtb.beder.edu.al](http://www.ejtb.beder.edu.al)

Likewise, digital applications in linguistic and literary studies have found their place in literary text analysis, digitization of archive and library resources, visualization of geographic and historical data, studies on folklore and popular traditions, digital teaching and educational platform, research on Albanian history and society, etc. These show, on the one hand, the applicability of DH studies and the need for their wider inclusion in studies of this type, to shed light on the various aspects of Albanian history, culture, and society.

### **Problems and challenges**

While Albania has a tradition of studies and research in digital applications within the humanities, the establishment of a dedicated study programme remains uncharted territory. Proposing such a programme presents challenges, despite the potential advantages it offers. These challenges include:

1. Access and use of technology: The Albanian education system still grapples with inadequate access to technology, as highlighted in the National Education Strategy 2021-2026, where the computer-student ratio falls short of EU standards (AMES, 2021, p. 51). Ensuring equal access to technology and digital tools for studying literature is imperative for the success of these programmes and the advancement of students, teachers, and researchers in their educational and research endeavours.
2. Quality and accuracy of digital resources: In an age of abundant digital information, evaluating the quality and accuracy of digital resources poses a significant challenge in literary studies. For instance, determining the original text of a work by an Albanian author amidst various published variants can be complex. Moreover, the digital format alters the concept of originality and authorship, given the multitude of communication

- channels with readers. (see Wymer, 2021, pp. 25-26). Establishing a university-level study programme helps standardize approaches to digital resources and their evaluation.
3. Integration of technology in teaching poses a challenge in effectively and sustainably utilizing it to enhance students' critical and analytical skills. While technology is increasingly prevalent in humanities education, its widespread adoption in the Albanian pre-university and university systems remains limited. During the COVID-19 pandemic, the shift to remote learning exposed issues with technology-enabled education (Albania. Ministry of Education and Sports, 2021, p. 51; Kelmendi et al., 2021, p. 6). To address these challenges, the experience of the National Institute of Educational Technologies and Teacher Training (INTEF) in Spain offers a successful model. They worked together with other agencies to create the Common Digital Competence Framework for Teachers (CDCFT), which serves as a descriptive reference for educational institutions. This framework aids in the training, assessment, certification, and accreditation processes based on Digcomp standards (INTEF, 2013; Yu Zhao, 2021).
  4. Privacy and security on the Internet present challenges when integrating DH into education, particularly regarding student data and online information security, as well as authorship rights for online materials. The use of data in education is a nuanced issue, as highlighted in "Minding the data: protecting learners' privacy and security" (UNESCO, 2022). Addressing these challenges requires clear and appropriate privacy and security policies, along with technical and legal measures to safeguard personal data and mitigate online risks. Resources such as the "Handbook of European data protection law" (Europe, 2018) and UNESCO guidelines are invaluable in this regard. UNESCO emphasizes the importance of striking a balance between leveraging technology for educational advancement and safeguarding privacy and individual rights. This requires the creation of guidelines and procedures at both national and international levels, promoting cooperation and joint efforts to facilitate policy learning, the exchange of knowledge, and mutual comprehension (UNESCO, 2022).
  5. Creating digital content: Creating quality digital content for teaching literature is a challenge for educators and requires the right skills and knowledge to create appropriate and high-quality materials, either from the point of view of the discipline, Literature, or from the way of applying digital methods in the research and transmission of this discipline.

6. Changing the paradigm of learning and teaching: The integration of technology in teaching requires a change of the paradigm of learning and teaching, requiring that pedagogues are able to use new ways of teaching and assessing learning, as well as orienting more to new perspectives in the way literature and culture are read and studied; the way the Albanian language is studied and used (Wymer, 2021, pp. 3-5).
7. Cultural and linguistic diversity: Ensuring that technology is appropriate and sensitive to the cultural and linguistic diversity of students, including diversified content and teaching tools in different languages and reflecting different experiences and cultures in the study of Literature constitutes a challenge in the application of DH programmes (O'Sullivan, 2023, p. 14).

### **Applications: Fields and subfields of study**

In the context of the deepening and orientation of studies, digital humanities find application and responds to diverse study subfields as specific disciplines of the programme, such as: digital textuality, data visualization and mapping, digital pedagogy, and Digital Humanities Research (O'Sullivan, 2023, pp.17).

Digital Humanities has a wide range of subfields of study, and there are the ways in which these subfields can be oriented and related to each other. Here are suggestions for ways in which each of these subfields can be oriented to DH, finding application in Albanian humanities studies:

#### *1. Digital Textuality*

*Digital text analysis:* This subfield involves the study and analysis of text in digital form. Students can study methods and techniques to analyse digital texts, including automatic text reading, frequency analysis, identification of text patterns, etc.

*Editing and digital publishing:* In this aspect, students can learn the techniques and tools to edit and publish texts in digital form, including the design of e-books, blogs, web pages, etc.

*Technologies for text interpretation:* This subfield focuses on the use of technology to help interpret text, including tools for text annotation, to create digital glossaries, to identify connections and concepts, etc.

#### *2. Data Visualization and Mapping*

*Data visualization:* This subfield involves developing data visualizations to convey complex information in clear and understandable ways. Students can learn the techniques and tools to create graphs, diagrams, maps, and other visualizations to represent various data.

*Digital mapping:* In this aspect, students can study digital mapping and the use of technology to create interactive and information-rich maps to display and analyse geographic and cultural data.

*Complex data analysis and modelling:* This subfield focuses on the analysis and modelling of complex data using modelling and data analysis techniques to break down and understand the relationships and patterns hidden in the data.

### 3. *Digital Pedagogy*

*Teaching in digital media:* This subfield includes the development of pedagogical practices and strategies to use technology in teaching. Students can learn about digital teaching tools and platforms, develop digital curricula and assignments, and integrate digital tools into their learning.

*Simulations and digital projects:* In this aspect, students can study ways to create and use simulations and digital projects to promote active learning and student participation in the learning process.

*E-curriculum and learning networks:* This subfield includes the development of e-curriculum and digital learning platforms, as well as the use of learning networks to aid student communication and collaboration.

### 4. *Digital Humanities Research*

*Studies on digital technologies and society:* This subfield focuses on research on the impact and use of technology in society, including the analysis of various social and cultural phenomena through a digital perspective.

*Joint projects and initiatives:* In this aspect, students can learn about joint projects and initiatives in the field of Digital Humanities, including collaboration with other research and science institutions to develop projects and innovations in this field.

These are just a few of how the Digital Humanities subfields of study can be oriented and connected to create a rich and relevant study experience. Creating a joint and multidisciplinary approach in these areas can bring additional value and innovation to the field of Digital Humanities studies.

## **Conclusion**

Examining the state of Albanian Language and Literature programmes in Albanian universities reveals a concerning decline in interest among students. This decline highlights the pressing need within the educational system for qualified teachers of Albanian language and literature. Considering these challenges, it is proposed that universities in Shkodër, Korçë,



Vlorë, Gjirokastrë, and Elbasan where interest in these programmes has waned, explore the integration of Digital Humanities (DH) into their curriculum.

The application of DH presents both challenges and opportunities. On the one hand, obstacles such as limited access to technology, faculty preparedness, and internet security pose significant hurdles. However, overcoming these challenges can result in a curriculum that meets the demands of the job market, produces well-rounded education specialists, and offers students a diverse skill set to navigate the evolving landscape of technology in the global workforce.

By embracing DH, these programmes can transition from being undervalued to becoming leaders in Albania's university landscape for humanities studies. Furthermore, they can play a vital role in fostering a new generation of researchers in Albanian studies.

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## **Media Impact on Children: A Parental Perspective**

Karlo Bojčić<sup>1</sup> and Goran Livazović<sup>2</sup>

<sup>1</sup>External associate of the Faculty of Humanities and Social Sciences, University of Osijek, Croatia

<sup>2</sup>Department for Pedagogy, Faculty of Humanities and Social Sciences, University of Osijek, Croatia

### **Abstract**

With children spending more time engaged with digital media, understanding its effects on their behaviour is essential. This research provides valuable insights into how various types of parental mediation are linked to children's aggression and media use. This study aimed to investigate the relationship between children's aggressive behaviour, their media consumption, parental mediation, and parental attitudes toward media. The research was conducted with 393 parents aged 24 to 50 who provided data on 401 children between November 2022 and March 2023.

The results highlighted a significant correlation between children's aggressive behaviour, parental attitudes toward media, and all three types of parental mediation. Negative correlation was found between restrictive mediation and the use of certain media, such as YouTube, mobile phones and video games, highlighting the importance of parental control in limiting access to potentially undesirable media content. The findings indicate a need for a thoughtful approach to parental mediation, emphasizing the delicate balance between protecting children from potentially harmful content and supporting their emotional and social development.

*Keywords:* aggression, children, media, mediation

### **Introduction**

Mobile phones, tablets, gaming consoles, computers and television are an important part of everyday life, as there are around 6 billion unique Internet and mobile phone users in 2024, representing almost 70 percent of the world's population (Kemp, 2024a). In Croatia, an average of 84 percent of the population are registered Internet users in 2024, with almost 5.5 million active mobile phones, exceeding even the total population number. This is not unusual, because many people around the world use more than one mobile phone. As for YouTube, Google's advertising resources indicate that 69.8 percent of the Croatian population are YouTube users (Kemp, 2024b). Children contribute to these statistics, given that Ciboci et al. (2014) reported

98,8% of preschool children using some kind of media, and Roje Đapić et al. (2020) reported 95% percent of children at the age of three being media users. By the age of six all children become media users.

The frequent exposure of children to different media content increased the scientific and general public's interest. Children are considered to be a particularly sensitive social group in a phase of forming attitudes, adopting and adapting to socialization frameworks and behavioural norms (Livazović, 2009). Diklić et al. (2019) indicate that media are becoming the main factor of socialization, suppressing school and family while influencing the formation of values and behavioural styles in children.

Television, Internet and video games have been the most studied media outlets, with research dominantly focused on the problem of receiving and elaborating media content (Sindik, 2012). Within various media experiences related to children and the media, especially television, the topic of aggressive behaviour attracted the most attention. Lemish (2015) pointed out that violence prevails in many commercial television programs, films, video games and websites, with one the reasons being the fact that viewers find violence exciting and easy to understand, regardless of language or cultural barriers. In trying to analyse the number of violent incidents to which an "average" child is exposed through the media, Lemish (2015) estimated that by the age of twelve, children mostly watching commercial television are exposed to about 20,000 murders and about 100,000 other aggressive acts. Since the 1960s and the simultaneous expansion of television and the Social learning theory, researchers have confirmed that watching violent movie characters enables children to learn new forms of aggression while encouraging their aggressive behaviour (Bandura, 1978; Coyne et al., 2017; Meysamie et al., 2013; Paik & Comstock, 1994; Singer & Singer, 2007). It is not only the exposure to violent media that impacts children's aggressive behaviour, it is the amount of time they spend in front of screens that significantly contributes to their propensity for aggressive behaviour as well (Heath et al., 1986; Keikha et al., 2020; Kelishadi et al., 2015; Manganello & Taylor, 2009; Robertson et al., 2013; Zimmerman et al., 2005).

Parents should be aware that their influence is not the only one the child will encounter in the "media world". The rest of the child's social environment also plays an important role: siblings, friends and relatives, kindergarten and school. Children are affected by what they receive through the media, which can be mediated through the lack of engagement from their closest social environment, personal passiveness, and emotional and intellectual unpreparedness for life with the media (Mikić, 2004).

Media research is viewed in the context of the ambivalence of the Theory of direct effects, which is focused on the predominant (negative) effects of media on the ideas, attitudes and opinions of recipients, and the Theory of limited effects which views media content as an amplifier of already existing ideas, attitudes and opinions, focusing on the negative as well as possible positive media effects (Livazović, 2009). The latter theory points out that recipients can control the impact of media content, whereby their control is influenced by various socioeconomic, cognitive and situational variables (Kunczik & Zipfel, 2006). Potter (2016) states that evidence of media involvement is most often sought in high-profile tragedies. Although such tragedies can be an indicators of media effects, due to their scarcity many believe they are not widespread and that even when they do occur, they happen to someone else. This phenomenon is also defined as the *third-person effect*, and it refers to the biased optimism according to which individuals exposed to media content believe this content will have a greater effect on other people than themselves, especially if those individuals belong to vulnerable groups such as children (Potter, 2016). The impact the parents expect media content to have on children may lead them to take certain actions, such as mediation.

Since the onset of communication research, scholars have been intrigued by parental strategies aimed at mitigating detrimental media influences on children. Recommendations have been made to restrict television exposure, highlighting its potential to shape children's consumer preferences, and emphasizing the role of parental modelling in children's socialization towards media consumption (Clark, 2011). Advancements in media technology have redefined the socialization process, leading to a modern approach to child rearing that emphasizes the importance of parental involvement in their children's digital media usage. One of the implementation methods for this new parental function is through parental mediation of media use (Rudnova et al., 2023). Parental mediation is defined as any strategy parents use to control, supervise, or interpret media content (Warren, 2001). There are three distinct types of parental mediation (Valkenburg & Piotrowski, 2017): restrictive mediation (limiting time or content), active mediation (explaining and evaluating content), and co-viewing (watching television together without discussing the content).

Active mediation is the most effective of these three strategies, as parents employing active mediation strategies demonstrate promising results in strengthening their children's critical thinking skills about media and safeguarding them from harmful media effects (Bielčíková & Hollá, 2022; Mendoza, 2009). According to several studies, active mediation provides favourable outcomes such as increased educational learning, improved prosocial behaviour, reduced aggression, minimized impact of advertising, and mitigated negative effects

of violent or sexual content (Bartaković & Sindik, 2016; Clark, 2011; Mendoza, 2009; Valkenburg & Piotrowski, 2017). Research indicates that restrictive media monitoring is not always effective and seems to work better with younger than older children (Valkenburg & Piotrowski, 2017). In their meta-analysis, Collier et al. (2016) further indicated that studies on restrictive mediation are rather inconsistent. While establishing rules regarding media consumption is linked to reduced verbal and physical aggression among children, research suggests that limiting the duration and content of television exposure may result in increased imitative aggressive behaviour, particularly among younger children. Clark (2011) additionally found that higher levels of restrictive mediation, such as too many rules, increased the level of aggressive behaviour in children. Just like restrictive mediation, co-viewing is insufficient without communication and selecting appropriate and inappropriate media content (Bielčiková & Hollá, 2022). Co-viewing can enhance a child's enjoyment, since children usually enjoy watching media content with their parents. However, co-viewing inappropriate media content like violence can lead to the child's aggressive behaviour, because the absence of discussion and pointing out what is wrong can be perceived by the child as approval of such behaviour (Nathanson, 1999).

A majority of parents reported using all three mediation strategies, depending on positive and negative attitudes about media (Nikken & Schols, 2015). A study by Iqbal et al. (2021, as cited in Corpuz et al., 2022) demonstrated that in eastern countries active mediation was the most utilized type of mediation, followed by co-viewing and restrictive mediation. A study by Warren et al. (2002) in the United States revealed that active mediation was the most frequent parental approach, followed by restrictive mediation and co-viewing. In Switzerland, Böcking & Böcking (2009) showed that parents used restrictive mediation most frequently, followed by active mediation and co-viewing. Croatian parents mostly reported using active mediation, followed by restrictive mediation and co-viewing (Bartaković & Sindik, 2016; Sindik, 2012).

Parental mediation practices are related to their views of the potential impact of media on their child (Warren, 2001). Research suggests that parents who are concerned about negative media impact on children tend to engage in more active mediation, such as discussing media content, and restrictive mediation, such as limiting screen time. Conversely, parents who believe in positive media effects are more likely to co-view programs with their children and engage in discussions about the content (Bartaković & Sindik, 2016; Nikken & Jansz, 2006; Warren, 2001).

## The present study

The presented research emphasizes the exposure of young children to media and the important role of parental mediation in shielding them from its negative impacts. Given the scarcity of research in Croatia and the opportunity to support educational efforts in enhancing parental media literacy, this study aims to explore the frequency of parental mediation and their concerns about potential negative effects of media on their children. Additionally, it seeks to examine the relationship between children's aggressive behaviour, their media consumption, parental mediation, and parental attitudes toward media. Based on the research aim, the following hypotheses were established: (H1): there is a significant correlation between children's aggressive behaviour and parental mediation; (H2): there is a significant correlation between children's aggressive behaviour and the amount of time children spend using media; (H3): there is a significant correlation between parental mediation and children's media usage; (H4): there is a significant correlation between parental mediation and parental attitudes toward media.

## Method

### *Measures and data collection*

The research was implemented via a pen-paper survey between November 2022 and March 2023. The questionnaire consisted of 5 major parts: socio-demographic measures; children's aggressive behavior; children's media use; parental mediation of media; and parental media attitudes.

a) The first part of the questionnaire collected data on the sociodemographic characteristics of the research respondents and their child (sex, age, parent's marital status, education, work status, number of family members, family income status).

b) The second part consisted of an 8 item scale with questions related to children's physically aggressive behavior in the last six months (*Hits/bites/picks/throws thing on other children; Starts fights with other children; Pushes other children to get what he/she wants; Takes toys and things from other children; Physically attacks people; Participates in fights; Destroys other people's things; Cruelty or mistreatment of others*) with three points (1-does not apply to my child; 2- somewhat or sometimes applies to my child; 3-often applies to my child). The Scale of physically aggressive child behaviour achieved a satisfactory Cronbach's alpha coefficient ( $\alpha = .81$ ).

c) The third part consisted of 4 non-standardized items on a 5-point scale (1-never, 2-up to 1 hour a day, 3-between 1 and 2 hours a day, 4-between 2 and 4 hours a day, 5-more than 4 hours a day) with questions about the time children spend with media (television; YouTube; mobile phone; video games on a computer, console or mobile phone).

d) The parental mediation scale was created for the purposes of this research by combining two questionnaires (Nikken & Jansz, 2006; Warren et al., 2002). It consisted of eleven items, four items form the restrictive mediation subscale (*I determine the time in which the child is allowed to use the media; I determine how much time per day the child can spend in front of the screen; I monitor what programmes or videos my child watches, what apps he/she uses, what video games he/she plays; I forbid my child to watch certain media content*), three refer to the co-viewing (*I consume certain media content with the child: We play video games, watch television...; I watch certain media content with the child because the child asks for it; I watch certain media content with the child on my own initiative*), and four refer to the active mediation (*I try to help the child understand what is happening on the screen; I point out positive things in media content; I point out negative things in media content; I explain to the child the reasons why a certain media character does what he does*). Items were evaluated on a five-point scale (1= never, 2= rarely, 3= sometimes, 4= often, 5= always). The Parental mediation scale demonstrated a satisfactory Cronbach's alpha coefficient ( $\alpha = .81$ ).

e) The last, fifth part of the questionnaire was based on the Parental attitudes toward television scale (Warren et al., 2002), with 5-point scale items that measured parents' concerns about potential negative effects of media use on their children (*I am concerned that watching inappropriate media may encourage my child to engage in risky behaviour; I am concerned that watching inappropriate media content will make my child less sensitive to hurting people; I am concerned that watching inappropriate media content will encourage my child to think that violence is acceptable; I am concerned that viewing inappropriate media content may encourage my child to use profanity; I am concerned that watching inappropriate media will frighten my child or cause nightmares*). The Parental attitudes toward media scale demonstrated a satisfactory Cronbach's alpha coefficient ( $\alpha = .93$ ).

Quantitative analyses were conducted using SPSS (v25.0.0) with descriptive and inferential procedures. The data was first processed for central tendency values on all measured items. A correlation analysis was implemented as to investigate the relation between children's aggressive behaviour, media use, parental mediation and parental attitudes toward media.



### *Participants*

The research was conducted with a convenient sample of 393 parents (326 females, 67 males) living in six different settlements in the region of Slavonia, who had a child between the ages of four and nine. The selection of six different settlements in Slavonia aimed to capture diverse socio-demographic characteristics of parents, facilitating broader regional insights, while ensuring cost-efficiency and accessibility for data collection. The parental age range was between 21 and 50 years, with most of them being between 31 and 40 (55.7%), followed by the age group 41 to 50 (21.6%), and then the 21 to 30 age group (9.9%). Fifty parents did not answer the question related to their age (12.7%). The majority of parents were married (89.3%), followed by divorced (5.6%) and parents in extramarital relationships (2.8%), widows or widowers (1.5%), and unmarried parents (0.8%). The majority of parents have two children (51.9%), followed by parents with three children (23.9%), parents with one child (12.7%) and parents with four or more children (6.9%). The majority of mothers have attained a high school education (57%), while nearly a third have university education (29.2%). Around one in ten have completed college (11.2%), with only a small percentage having finished only elementary school (2%) and an even smaller fraction not completing elementary school at all (0.5%). As for fathers, most have completed high school (65.9%), with close to a fifth holding university degrees (19.2%). Thirty fathers have completed college (7.65%), while a smaller portion have only elementary school education (4%) and a few have not finished elementary school (0.8%). Most mothers are fully employed (71.3%), with nearly a fifth experiencing unemployment (19.6%). There are 32 mothers who are employed on occasion (8.1%), and three mothers who are retired (0.8%). On the other hand, the majority of fathers hold full jobs (89%), while 16 are currently unemployed (4%). Nine fathers were retired (2.3%), five worked on an occasional basis (1.3%), while there is no recorded response for 13 (3.3%) respondents.

### **Results and discussion**

Our findings indicate that media play a pivotal role in children's lives starting at a young age, with nearly all children (99.8%) engaging with at least one form of media daily. Previous research conducted in Croatia yielded comparable findings, with Ciboci et al. (2014) reporting that 98.8% of children utilize at least one form of media daily. Additionally, findings from Roje Đapić et al. (2020) indicate that all preschool-age children engage with some form of media.

The results of this research indicate that television remains the most popular medium with which children spend the most of their time. Almost all children (93.7%) are regular TV viewers, and almost half of them (49%) spend a minimum of one hour per day in front of the

TV screen. YouTube emerged as the second preferred media platform, with 88% of children engaged. Mobile phones (81.1%) and video games played on different platforms such as computers, consoles, or mobile devices (77.7%) were the third and fourth preferred media outlet. Similar findings were established in a study by Karačić et al. (2022), indicating that 96.6% of children partake in television watching, 88.3% of children visit YouTube, 81% watch movies on a mobile phone or tablet and 44.7% play video games. Comparable findings, further affirming television's leading position as the preferred media among children, followed by YouTube, mobile phones, and video games, were also obtained by Ciboci et al. (2014), Karačić and Pasković (2022) and Roje Đapić et al. (2020).

Our findings are in line with results from Nikken & Schols (2015), demonstrating that the majority of parents employ all three forms of mediation. Restrictive mediation emerged as the most prevalent, followed by active mediation and co-viewing, which is similar to findings obtained by Böcking and Böcking (2009). These results are encouraging, as they reflect parental proactive involvement in managing the child's media consumption, with a focus on guiding and educating them about the content they engage with. Through careful content selection and moderation of screen time, parents are fostering responsible media habits and aiding their child's cognitive growth. Furthermore, actively discussing media content and exploring character motivations may serve to mitigate the adverse effects of inappropriate media content and foster prosocial behaviour in children. Table 1 provides descriptive data on the primary research variables.

*Table 1. Descriptive statistics on the main research variables*

<b>Variables</b>	<b>N</b>	<b>M</b>	<b>SD</b>	<b>Min</b>	<b>Max</b>
Media usage by children					
Television	398	2,53	,78	1	5
YouTube	391	2,28	,80	1	5
Mobile phone	396	2,32	,96	1	5
Video games on a computer, console or mobile phone	395	2,12	,83	1	5
Parental mediation					
Active mediation	401	4,10	,70	1	5
Restrictive mediation	401	4,26	,69	1	5
Co-viewing	401	3,31	,69	1	5
Parental attitudes toward media	401	3,61	1,05	1	5
Children's aggressive behaviour	400	1,05	,15	1	2,5

The first hypothesis (H1) assumed that there is a significant correlation between children's aggressive behaviour and parental mediation. Our results (Table 2) demonstrate a very weak positive correlation between children's aggressive behaviour and restrictive mediation ( $p < .05$ ), and a very weak negative correlation between children's aggressive

behaviour and active mediation ( $p < .05$ ) and co-viewing ( $p < .05$ ). Unlike our results, Nathanson (1999) found a negative correlation between parental restrictive mediation and children's aggression, reporting no significant relationship between co-viewing and children's aggression. Some research inconsistencies on restrictive mediation and co-viewing were already highlighted. While setting boundaries on children's media use may decrease their aggression, restricting media exposure in terms of both duration and content could potentially result in their heightened aggression. Also, engaging in co-viewing of prosocial media content may lead to a decrease in a child's aggressive behaviour. Consistent with our findings, Clark (2011) revealed that employing restrictive mediation may lead to an increase in children's aggressive behaviour, and Collier et al. (2016) and Valkenburg & Piotrowski (2017) also found negative correlation between parental active mediation and children's aggression. Persuasion-based theories, like Inoculation theory, suggest that parents' active monitoring of media can help children develop immunity to persuasive messages in TV content, potentially reducing long-term effects on behaviours such as aggression and externalizing behaviours (Padilla-Walker et al., 2016). The results of this study confirm the first hypothesis, which assumed a significant correlation between children's aggressive behaviour and parental mediation.

The second hypothesis (H2) proposed a significant correlation between children's aggressive behaviour and the amount of time children spend using media. Our study did not establish a correlation between the child's physical aggression and the amount of time they spend with media. Our findings were not in line with those reported in previously analysed studies (Heath et al., 1986; Keikha et al., 2020; Kelishadi et al., 2015; Manganello & Taylor, 2009; Robertson et al., 2013; Zimmerman et al., 2005). However, Anderson et al. (2007), Sakamoto (1994) and Van Schie & Wiegman (1997), also found that the time spent in front of screens does not correlate with aggressive behaviour in children. Anderson et al. (2007) emphasized that the frequency of aggressive behaviour is primarily influenced by the content of the media, particularly the presence of violence. Based on the findings of this study, the hypothesis suggesting a significant correlation between children's aggressive behaviour and the amount of time they spend using media can be rejected.

The third hypothesis (H3) assumed that there is a significant correlation between parental mediation and children's media usage. Our results demonstrate a very weak positive correlation between children's television watching and co-viewing ( $p < .05$ ), and a very weak to weak negative correlation between restrictive mediation and children's engagement with YouTube ( $p < .001$ ), mobile phones ( $p < .001$ ), and video gaming ( $p < .001$ ). There is no established correlation between active mediation and any form of children's media

consumption. The relationship between television viewing and co-viewing can be understood within the social context of media consumption. Watching television remains predominantly a social activity within families. Conversely, newer digital media, such as mobile phones, YouTube, and video gaming consoles, are typically solitary activities, with less emphasis on intergenerational interaction (Nikken & Schols, 2015). Since parents may have limited visibility and control over the content their children access on these platforms, compared to television viewing, they may decide to impose stricter rules or limitations as a form of protective measure. The results of this study confirm the hypothesis that there is a significant correlation between parental mediation and children's media usage.

The fourth hypothesis (H4) assumed there was a significant correlation between parental mediation and parental attitudes toward media. We established a very weak to weak positive correlation between parental attitudes toward media and their application of active mediation ( $p < .001$ ), restrictive mediation ( $p < .001$ ), and co-viewing strategies ( $p < .05$ ). Prior studies consistently revealed that parental concerns about the potential negative consequences of their children's media consumption serves as a reliable indicator of parental mediation (Bartaković & Sindik, 2016; Nikken & Jansz, 2006; Valkenburg et al., 1999, as cited in Warren, 2001; Warren, 2001). This highlights the importance of considering parental attitudes when designing interventions and educational strategies to promote healthy media habits among children. Understanding and respecting parental concerns and preferences can enhance the effectiveness of interventions aimed at promoting responsible media use and minimizing potential negative effects on children's well-being. The study's findings confirm the hypothesis that there is a significant correlation between parental mediation and their attitudes toward media.

**Table 2.** Correlation matrix on media use by children, parental mediation, parental attitudes toward media, and children's aggressive behaviour

Variables		1	2	3	4	5	6	7	8	9
1 Television	<i>r</i>	/	,08	,04	<b>,14**</b> <sub>*</sub>	,02	,04	<b>,13*</b>	,01	-,02
	N	398	388	395	393	398	398	398	398	397
2 YouTube	<i>r</i>	,08	1,00 0	<b>,53**</b>	<b>,37**</b>	-,03	<b>-,18**</b>	-,01	,04	-,02
	N	388	391	389	387	391	391	391	391	390
3 Mobile phone	<i>r</i>	,04	<b>,53**</b>	/	<b>,49**</b>	,06	<b>-,20**</b>	-,00	-,03	-,00
	N	395	389	396	393	396	396	396	396	395
4 Video games on a computer, console or mobile phone	<i>r</i>	<b>,14*</b> <sub>*</sub>	<b>,37***</b>	<b>,49**</b> <sub>*</sub>	/	-,04	<b>-,20**</b> <sub>*</sub>	,02	-,03	,05
	N	393	387	393	395	395	395	395	395	394
5 Active mediation	<i>r</i>	,02	-,03	,06	-,04	/	<b>,38**</b> <sub>*</sub>	<b>,34**</b> <sub>*</sub>	<b>,25**</b> <sub>*</sub>	<b>-,12*</b>
	N	398	391	396	395	401	401	401	401	400
6 Restrictive mediation	<i>r</i>	,04	<b>-,18***</b>	<b>-,20**</b> <sub>*</sub>	<b>-,20**</b> <sub>*</sub>	<b>,38**</b> <sub>*</sub>	/	<b>,24**</b> <sub>*</sub>	<b>,26**</b> <sub>*</sub>	<b>,11*</b>
	N	398	391	396	395	401	401	401	401	400
7 Co-viewing	<i>r</i>	<b>,13*</b>	-,01	-,00	,02	<b>,34**</b> <sub>*</sub>	<b>,24**</b> <sub>*</sub>	/	<b>,11*</b>	<b>-,11*</b>
	N	398	391	396	395	401	401	401	401	400
8 Parental attitudes toward media	<i>r</i>	,01	,04	-,03	-,03	<b>,25**</b> <sub>*</sub>	<b>,26**</b> <sub>*</sub>	<b>,11*</b>	/	,09 3
	N	398	391	396	395	401	401	401	401	400
9 Children's aggressive behaviour	<i>r</i>	-,02	-,02	-,00	,05	<b>-,12*</b>	<b>,11*</b>	<b>-,11*</b>	,09	/
	N	397	390	395	394	400	400	400	400	400

Note:  $p < .05^*$ ;  $p < .01^{**}$ ;  $p < .001^{***}$

### Limitations

This study has several limitations. The results were obtained on a relatively small research sample, thus limiting their broader applicability. Also, results obtained on a geographically restricted sample may not be applicable to other regions with different sociodemographic characteristics. The use of self-reported measures may introduce bias, as

respondents may interpret events differently. The correlational nature of the analysis prevents the determination of causal relationships between the variables. Finally, the parental mediation questions also addressed general media habits instead of specific media content. For instance, future research could investigate the frequency and strategies employed by parents when addressing violent media content.

## **Conclusions**

Despite its limitations, our findings demonstrate significant implications for parents and educational professionals. Most parents employ all three forms of mediation, with restrictive mediation being the most prevalent, followed by active mediation and co-viewing. These findings are encouraging, particularly considering the confirmation of the first hypothesis, which assumed a significant correlation between children's aggressive behaviour and parental mediation. Our findings indicate that parents are actively involved in overseeing their children's media use, emphasizing guidance and educational efforts regarding the media content accessed by children. The second hypothesis, suggesting a significant correlation between children's aggressive behaviour and their media consumption time, was rejected, indicating that aggressive behaviour is primarily influenced by the specific content of the media rather than the duration of exposure. Our results confirmed the third hypothesis, indicating a significant correlation between parental mediation and children's media usage. Co-viewing remains prevalent in children's television viewing, underscoring its social nature within family contexts, while newer digital media tend to facilitate more solitary interactions, potentially necessitating stricter parental oversight as a form of protective measure. The fourth hypothesis, assuming a significant correlation between parental mediation and their attitudes toward media, was confirmed by our study's findings, as well. Parental concerns about media influence on their children may serve as a reliable indicator of their mediation.

Our study emphasizes the proactive role parents take in regulating their children's screen time and highlight the necessity for tailored measures to support effective mediation practices. Understanding the obtained correlations can guide interventions aimed at enhancing media literacy for both children and parents, promoting responsible media habits within families.

Considering the lack of research on this topic in Croatia, this study contributes to knowledge about the frequency of parental mediation and their concern about the possible negative effects of the media on their children. In addition, it contributes to knowledge about the relationship between children's aggressive behaviour, their media consumption, parental mediation, and parents' attitude towards the media.

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## **Social Media Generators In Literature Teaching**

Vedrana Živković Zebec

Faculty of Education, University of Osijek, Croatia

### **Abstract**

In contemporary teaching, traditional methods of literature teaching are being abandoned in favour of modern approaches to literature, in which learning outcomes are achieved through problem-solving, creative and collaborative tasks, requiring students to develop various expressive, artistic, creative, as well as digital and other abilities. Utilizing the resources offered by electronic media can bring multiple benefits to the educational process, from significantly boosting student motivation to fostering creativity and multiliteracy. The research explored how to stimulate student motivation and creativity and achieve learning outcomes using social media generators of Instagram and Facebook in post-reading activities.

Students created character profiles from novels they read, adapting the language level to the chosen social network, changing the narrative perspective and using multimodal resources in task realization. The multimodal features of social network generators provided students with new ways to present their ideas, works and conclusions. The tasks given to students seemed simple at first and had great motivational potential, but their implementation required student engagement, critical thinking and the linking of cause-and-effect relationships, as well as collaboration.

*Keywords:* social media generators, multiliteracy, literature teaching, extensive reading

### **Introduction**

Understanding literacy today is changing, and it is under the constant influence of technology that we use daily. There is a growing need for acquiring multimodal literacy which is understood “as socially framed active engagement with a range of texts”, offering researchers a perspective on “how multiple modes work together to create meanings where language may or may not play a central role” (Flewitt, 2013, p. 297). Today's children and students are known as "digital natives" (Prensky, 2000), which means that they are growing up using digital media on a daily basis. Marchetta et al. (2018) state that they are characterized by traits such as technological proficiency, enhanced multitasking abilities, a preference for social learning and collaboration, and a greater focus on graphs and images over text.

Considering that technology is an integral part of children's and young adults' lives, it is increasingly being incorporated into teaching in order to enhance the teaching process and learning experience. In this paper, we will present how social network generators can be used in literature teaching and what their advantages are compared to social networks. Social network generators provide a simulation of the content and form of the selected social network and differ from social networks in that the created content is not published publicly. The paper will demonstrate how the Zeeob (<https://zeoob.com/>) and Fakebook ([www.classtools.net/FB/home-page](http://www.classtools.net/FB/home-page)) generators can be used for post-reading activities and their creative possibilities and connections to learning outcomes. Both tools can be used free of charge and students can easily navigate them.

Today, motivating students to engage and focus on reading literary works is challenging as they often have negative attitudes towards required readings. Additionally, Gabelica and Težak (2019) state that it is necessary to adapt methodological approaches to the processing of literature in order to eliminate negative attitudes towards literature. The paper aims to present the possibilities that these tools have in updating literature teaching, connecting literature with students' extracurricular experiences, and achieving outcomes by fostering student creativity, developing narrative and language skills, and enhancing student multimodal literacy.

### **Defining social networks**

Given that the paper will demonstrate how social network generators can be used in education, it is necessary to explain the main features of social networks, i.e., what distinguishes generators from social networks. Social networks are designed in a way that the content can be shared in various ways with others, and definitions of social networks emphasize their communicative purpose, as Robbins and Singer (2014, p. 387) define social networks as “any technology that facilitates the dissemination and sharing of information over the Internet.” McCay-Peet and Quan-Haase (2016, p. 6) specify the use of social networks, defining them as “web-based services that allow individuals, communities, and organizations to collaborate, connect, interact, and build community by enabling them to create, co-create, modify, share, and engage with user-generated content that is easily accessible.” On the other hand, social network generators simulate the main characteristics of social networks (user profiles can be shaped, posts containing all information as on a social network such as location, followers' reactions, and comments), but their content is not published publicly and all interactions are simulated. Users who are familiar with using social networks will easily navigate when using a generator.

## **Social networks in teaching**

The possibilities of using electronic media, including social networks in teaching, have been researched since their intensive development in the first decade of the 21<sup>st</sup> century, and the papers point out the positive and negative aspects of incorporating electronic media into teaching. Since the topic of the paper is social network generators, we will focus on the possibilities that social networks offer in the teaching process. Although social networks have many negative implications, studies show that they are increasingly being integrated into the educational process and have benefits at various levels. The use of social networks leads to the development of collaboration and critical thinking, as well as active participation in the educational process (Shih, 2011; Stone, 2017) and one of the important factors highlighted is the development of student creativity (Vilarinho-Pereira et al., 2021).

This paper presents the possibilities of using social media generators in literature teaching, where the social media content is simulated. Previous research covered various forms of using social media in teaching through different methods, theoretical frameworks, and researched disciplines. One common conclusion is that there is a connection between integrating web 2.0 tools into teaching and fostering student creativity and motivation. Stewart (2016) emphasizes that more research has been conducted on how users felt, rather than being focused on the learning process and outcomes, but also cites examples of the positive impact of social media on skill development and according to Stornaiuolo et al. (2013) social media can be powerful tools that unite a diverse range of knowledge, perspectives, and practices. It is also essential to choose appropriate methods and tasks in order for the integration of technology to make sense, rather than being used solely for its entertainment aspects (Hew & Cheung, 2013; Mattewmann et al., 2004; McGrowen, 2024; Vilarinho-Pereira et al., 2021).

The use of electronic media and social networks does not guarantee the success of the educational process. It is necessary to integrate the use of media into the objectives to be achieved through teaching and the attainment of learning outcomes. Vilarinho-Pereira et al. (2021) emphasize that social networks as tools in the educational process do not automatically lead to the development of creativity. Specific methods need to be developed to integrate social networks into the educational process and to ensure that this tool is successfully and meaningfully incorporated into the educational process.

In addition, it is important to consider the limitations that may arise when students are required to use the same social networks for both extracurricular activities and educational purposes. Stewart (2016, p. 494) emphasizes that “even if students are comfortable with social

media outside of school, they may not know or understand how to use them in an academic context, repurposed or not.” They use social media for fun, games and communication and they are often only users, not content creators, while educational practice considers students to be content creators in order to develop their skills and knowledge. As a complicating factor, students may encounter public disclosure of content that social networks require in a certain context, raising the issue of privacy. Social media generators offer a different perspective by simulating social media content, maintaining the privacy of posts and enabling the acquisition of knowledge and experience through the creation of fictional posts. The use of social media generators eliminates the potential barriers social media can impose on creativity. Runco (2015) emphasizes the incompatibility between the extrinsic orientation (e.g., likes, visibility, pressure to convey) of social media and the unconventional lines of thought and intrinsic nature of the creative process. The selection of social media generators removes extrinsic factors because student works are not publicly published and are not subject to public evaluation, likes, comments, which reduces the pressure on students and allows for greater freedom of expression and creativity. Tasks are focused on student creativity and task goal achievement, not on publishing results and public reactions (public posting within the classroom community is considered positive and another motivating factor).

### **Social networks and activities related to reading**

The use of media in teaching can be a motivational factor that will encourage students to engage in active reading and creative creation (Childs et al., 2015). Considering that today children and young adults mostly spend their free time with electronic media, not using book forms or reading activities, Chew and Lee (2013, p. 152) consider that: “To increase the potential of success of the ER program, it is only logical to look to digital technology and media this generation is comfortable with for an alternative platform to the traditional approach.”

Furthermore, we will present some research linking language activities and reading and the use of social networks. Bakla (2020) emphasizes the ease of creating user-friendly tools on social media as an important factor and, using the example of blogs, demonstrates how social media can be integrated into the literary teaching process (extensive reading) to improve students' reading skills and creativity. However, some students engage in activities that are simple and lack originality. The positive role of blogs and Facebook is emphasized by Chew and Lee (2013) who determined that the blog motivated the students not only to read more, but to read more carefully and purposefully. Facebook, which was extremely popular at the time of the research by Chew and Lee (2013), also had an encouraging role because another focus group

member confirmed that this social network can help reduce the academicness of the activity and remove the pressure of perceived expectations from both peers and instructor, thus making this approach to extensive reading more casual and engaging.

Instagram has the same characteristics and can be utilized in the classroom as well as in reading activities. Handayani (2016) connects activities by using Instagram in four language skills: speaking activities (review famous person in history, role play, Pronunciation Plus, etc.), reading activities (book recommendation, making book trailers), writing activities (Caption it!, Photo inspiration), listening activities (Listening to the natives) and concludes that “Instagram give beneficial effect in improving students’ language skill. It is a useful education tool in giving students and teachers an easy way to communicate that goes beyond office hours and classroom. Using Instagram allows students to generate ideas with contextually-relevant content and offers them a learning experience that they enjoy” (Handayani, 2016, p. 326). Ávila (2021) also used Instagram connected to reading activities in university English classes in order to increase students’ engagement. Students were familiar with Instagram and its visual nature. Using Instagram provided student engagement and had positive feedback from students but the author also addressed the controversy of using Instagram in teaching like digital curation and authorship concerns.

Teachers today encounter many ideas and there is great potential in incorporating technology and social networks into teaching. “Undoubtedly, these will vary depending on the culture, context, and power within the classroom as well as the theoretical underpinnings that the teacher brings to bear on these key factors” (Stewart, 2016, p. 491).

### **Theoretical framework**

This paper will present the possibilities of social network generators in teaching literature and the way in which students used them to creatively complete tasks related to extensive reading. Although the concept of extensive reading is ambiguous and refers to reading various texts in different contexts (cf. Gabelica & Težak, 2019), it is most commonly identified with reading complete works as part of language subjects. Extensive reading does not mean just reading, but it is associated with additional tasks that students complete at home or in class, and they influence the grade in a comprehensive or partial manner. The main role of reading assignments is to improve reading skills, vocabulary, spelling, and writing (Krashen, 1993) and as part of literary education and upbringing, to develop a positive attitude towards literature in students and encourage independent reading and critical thinking. Therefore, it is very important that the tasks given to students have a motivational potential. Although reading per

se could provide the motivation that students need to read more, stimulation and fun post-reading activities also have a motivation potential. “In extensive reading projects, post-reading activities are done, so that students could take responsibility of their learning and benefit from ER activities. However, some of these activities, such as asking students to prepare written summaries or to do grammar exercises, may prove counter-productive and cause students to lose motivation for reading” (Bakla, 2020, p. 3132). New approaches to extensive reading connect post-reading activities and creativity (Gabelica & Težak, 2019) and Bakla (2020) states that creativity “is one of the twenty-first century skills that is usually a critical component of education” (Bakla, 2020, p. 4).

The use of social media platforms aims to integrate teaching and learning purposes and encourage student creativity. In our tasks students were “learning through design” (Kafai & Resnick, 2011, p. 4). The specific tasks involved creating a profile of a chosen character from a novel on a social network (Instagram or Facebook), where students, in creating the profile identity, were required to encompass various components of identity formation on social media (visual, textual, auditory, etc.) and change the narrative perspective as the novels selected for the task were written in the first or third person. Thus, the task designed for students demanded “higher order skills and require learners to synthesize and apply their knowledge” (Kafai and Resnick, 2011, p. 4).

The theoretical framework of tasks given to students is based on Kress's (2010) conceptions of multimodal meaning design. Multimodality examines multiple aspects of communication and meaning making. “The twenty first century is awash with evermore mixed and remixed images, writing, layout, sounds, gesture, speech and 3D objects” (Kress, 2010, p. ii). Multimodal features of social networks (or their generators) provide students with new ways to present their ideas, works and conclusions. Meaning is shaped not only by textual elements, but students have the choice of which multimedia content will serve them in completing the task (images, music, video material, text, emojis, etc.) and they become content creators. In this way, the concept of literacy is expanded, and students practice and acquire other forms of literacy necessary in the modern world and according to Kress (2010, p.1) “it is no longer possible to think about literacy in isolation from a vast array of social, technological, and economic factors.”

Creating a profile of novel characters on the selected social network generator aims to enhance student creativity and address the following educational tasks:

- a) adapting linguistic elements



The language in the task should be in line with the common language use on the selected social network (Facebook or Instagram), and students should also use so-called "digital speak". In this way, they develop "communicative competence" (Bachman, 1990; Canale & Swain, 1980; Hymes, 1973) which encompasses understanding the difference in communication on a selected social network compared to the formal register expected in the classroom.

b) narration with a change in perspective

The tasks assigned to students require narration with a change in point of view. "Point of view, in literary studies, describes the position from which a narrative is told; it is the vantage point from which its events, situations, and characters are presented to the reader" (Steffen, 2010, p. 1).

There are three points of view and in literary texts the author may use one or more points of view: first, second and third person. By changing the narrative perspective, events can be portrayed differently, depending on the character from whose perspective the events are being told, and the story can vary depending on the point of view. Assignments in which students create character profiles have opened up the possibility of presenting the story differently depending on the viewpoint of the selected character. "An ability to explore various realizations of the narrative according to the characters' perspective would be a powerful tool to explore the narrative space" (Charles et. al., 2010, p. 1683). By utilizing narrative perspective shifting in teaching and adopting first-person speech, there is a deeper immersion into the structure of the text and engagement with its world.

## **Methodology**

The aim of the study is to investigate how extensive reading and the use of social media generators can be an effective method for students to enhance their creativity and for the realization of learning outcomes. We applied the action research method and the results will be presented using the descriptive approach. Descriptive data from students' work will show how successfully students solved the task, whether they successfully achieved a shift in narrative perspective and depicted relationships among characters, as well as how they realized the linguistic-communicative and visual aspects of the task. The activities samples were used to illustrate the characteristics of the post-reading activities.

The paper uses the examples of tasks that students worked on in the course "Contemporary Media in Literature Teaching" to demonstrate how they approached creating

character profiles from selected novels. A total of 52 students participated in the task, with 22 profiles being made by students working in pairs or groups of three.

The students were given a choice of two novels: *The Green Dog* by Nada Mihelčić, intended for a teenage audience, and the novel *The Gang of Pero Kvržica* by Mato Lovrak, intended for children. They could choose which character would be represented on their profile, and they were given clear instructions to help them create the profile more successfully and achieve the three main objectives of the task – the adaptation of linguistic elements, successful storytelling with a change of perspective that involves reflection on relationships among characters and the development of student creativity by creating new linguistic, visual, and auditory content on a social media platform generator.

In the task, two social media generators were used: Zeeob (<https://zeob.com/>), which offers the possibility of simulating posts from various social media platforms (Snapchat, Instagram, Facebook, TikTok, WhatsApp, etc.). The students were using the Instagram generator on Zeeob for designing posts. The other tool was Fakebook ([www.classtools.net/FB/home-page](http://www.classtools.net/FB/home-page)), which simulates a Facebook profile. The generators differ in some aspects, i.e. Fakebook enables the creation of a full character profile with a complete profile description (profile pictures, intro, friends, etc.), whereas on Zeeob generator, posts are formatted, not profiles, so after the posts were formatted, students had an additional task of combining them into one document to complete the task. The assignment required the students to create profiles with at least 10 posts in order to clearly demonstrate the perspective of the character and the relationships among the characters, which could vary depending on the plot.

#### *Instructions for students*

It is important to provide students with clear instructions so that they can achieve the task in its entirety and so that certain elements that differentiate social networks from formal education would not be limiting factors.

##### a) linguistic elements

In the instructions, it is important to emphasize that the students should use language as they do in their everyday extracurricular environment on social media so that thinking about proper linguistic expression does not deprive them of creativity and the authenticity of the profiles they create. The success of the task will be measured by the use of language adapted to the social network. Creating a profile on a social network requires adapting linguistic aspects

of the language of social networks characterized by the use of emoticons, irregular grammatical constructions, the lack of punctuation marks, etc.

b) character perspective

The students were able to work on a character of their choice from one of the two proposed works. After choosing the character, they were required to create their profile or posts on a social network in which selected parts of the plot or selected motifs would be included. The students were asked to change the narrative perspective and this change influenced the connections and conclusions about the characteristics of the characters, their language, and relationships and contacts with other characters when making profiles on social media.

Taking the perspective of the selected character, they should have presented the plot through the character's profile, important events (not only key events, but also some less significant ones within the plot, yet crucial for the character's perspective), self-presentation of the character or characterization of the selected character, and interactions and relationships with other characters. The reflection on the relationships among characters as well as the characters they interact with on profiles is very important because the students had to think about cause-and-effect relationships in this way, which influences the success of task performance. The comments and reactions from other characters should demonstrate the relationships among characters and their characterization, and students should show their language skills and ability to create new content through comments.

c) selection of visual elements

Since both social networks have multimedia and multimodal functions by combining visual, auditory, and textual elements, the students were required to design posts using photographs of selected motifs accompanied by a description of the photograph, hashtags, location and comments. When selecting a photograph, it is important to connect the motifs of the work, the time of the action, and the chosen events and moods of the characters, while the comments should reveal the relationships among the characters and recognize their characterization. The students could use their own photographs or download images from the internet.

e) forms of work

Task creation can be organized in groups, pairs or individually. When assigning the tasks, the students were allowed to work in pairs or groups of three in order to exchange ideas,

promote collaboration and stimulate creativity. The task can be expanded so that students in a group have to present the perspectives of different characters and through comments show their interaction related to the plot and characterization of the characters.

### *Presentation of results*

The study included 22 character profiles from assigned novels, including 220 posts. The results showed that 18 students chose to use the Instagram generator. This can be interpreted as Instagram's greater popularity among the student population in recent years.

a) The linguistic elements in the tasks were successfully completed. The students accepted and demonstrated ways of communication typical for social networks by using jargon, abbreviations, emoticons and omitting punctuation marks. The linguistic part of the task was indeed the best part of creative expression and creation. By changing perspectives, the students described images, added hashtags while the comments revealed the relationships among characters. The comments in the task about the novel *The Gang of Pero Kvržica*, contained some humorous remarks, which increased their creativity and attractiveness, without going beyond the task framework. In the profiles from the novel *Green dog*, which has a more serious theme, humorous comments were less frequent and were related to the initial parts of the novel's plot, when the situation is not yet serious. The descriptions of the images were created independently, only in some cases containing quotes from the book, while the comments were entirely independently created, following the communication style on social media – short comments prevailed, with some comments expressed solely through emoticons. In the data, most students used an informal code, a form of "texting".

b) In all examples, the students changed the character's perspective. The assigned novels are written from different perspectives, *The Gang of Pero Kvržica* has an omniscient narrator and the students chose the character Pero, the main character and the driving force of the action, to create a profile. *The Green Dog*, which addresses the issue of drug addiction in family, is written from the perspective of the narrator who is the younger sister of an addict. The students did not choose the perspective of the narrator, but the perspective of her sister, the addict.

The task of creating a character profile may seem simple and interesting, but when creating profiles, the students were required to think about causal relationships, plot development and character relationships projected in the comments. Part of the task was not successfully completed because the students did not think through which characters "may" see posts on the profile. In the novel *The Gang of Pero Kvržica* children try to keep certain things

hidden from adults, so this aspect had to be considered when creating character profiles. Namely, on the Fakebook profile, a part of the students listed Pero's parents and teachers as friends, which is contradictory to the novel's plot, and on the Instagram profile, in some instances, parents commented on posts, which is also contradictory. The task, which seems simple and interesting, proved to be more challenging because in order to successfully complete it, it was necessary to understand all relationships among the characters and causal relationships in the novel.

The selection of the perspective depending on the drug addict in the novel *The Green Dog* has also proven to be challenging as the issue of addiction is not openly discussed. By adopting the addict's perspective, the students focused more on her psychological states and moods, avoiding the taboo aspects associated with addiction. Although some key parts of the plot were omitted in this way, the tasks were successfully completed as the students thought about cause-and-effect relationships and the issues of the novel. Considering that the addict dies at the end of the novel, in one completed task, the students included a post about her death on the profile, noting that her brother is the one writing on the profile and that they are leaving the profile in memory of Vlatka, the addict.

c) When selecting photos, the students were given a choice – they could use photos from the Internet (with a recommendation to download photos from websites where photos are freely available for download) or their own photos<sup>7</sup>. For this task everyone used existing images from the Internet. Previous research has shown that students tend to resort to ready-made materials, as evidenced by some previous studies indicating that students used and compiled available materials from the Internet (see Bakla, 2020). Since the photographs were only a part of the task, the selection of photographs did not affect the successful completion of the task. However, not all students successfully completed that part of the task. Novel *The Gang of Pero Kvržica* has a more distant narrative time from the first half of the 20<sup>th</sup> century. In four tasks, the students did not properly connect the time of the action with the selected photographs, and they used photos on profiles showing children in modern clothing and with modern hairstyles, as well as photos depicting motifs from a more contemporary era (e.g., calculator, digital thermometer). In this way, they did not properly connect the time of the action and the character's perspective,

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<sup>7</sup> The novel *The Gang of Pero Kvržica* has been adapted into a feature film. The students were instructed not to use the photos from the film when creating profiles. This task was also conducted in the previous generation, but the students were not informed that they should not use photos from the film. The results at that time showed that half of the students used the photos from the film in shaping their profiles, thus facilitating the selection of motifs and key events.

nor did they standardize the profiles, which were predominantly linked with photographs related to the time of the action. In this way, the selection of photographs also proved to be a task that requires reflection, connection, and inference in order for the task to be successfully completed, and for the character profiles to be meaningfully designed.

f) The students worked on the tasks in pairs or groups of three, and this form of work proved to be motivating and stimulating.

## **Conclusion**

Utilizing the resources offered by electronic media can bring multiple benefits into the educational process, from significantly boosting student motivation to fostering creativity and multiliteracy, all while being connected to achieving learning outcomes. The paper demonstrates how social media generators like Instagram (Zeeob.com) and Fakebook ([www.classtools.net/FB/home-page](http://www.classtools.net/FB/home-page)) can be utilized in post-reading activities. The students were required to create character profiles from the novels they read, adapting the language level and register to a chosen social network, changing the narrative perspective and using multimodal resources in task completion. Through this activity, new forms of literacy thinking were strengthened, connected to multimodal learning and literacy practices with the idea that “in contemporary conditions,” “writing, previously the canonical mode par excellence, is giving way to image (...)” (Kress, 2010, p. 133). The task concept included the development of digital literacy at multiple levels, from navigating the use of social media generators, through searching, downloading, and editing photos to linking multiple posts into a unified document (which was necessary for tasks on the Zeeob tool).

Students in everyday life are regular users of social media platforms Instagram and Facebook, as well as others not covered by this task. The use of social media generators was new to them, but considering that the content is simulated in the same way as on social media platforms, they easily adapted. The advantages of the generators are that the tasks were not publicly posted outside the student group, and thinking about public reactions, comments, likes, and similar was not a negative factor. The tasks given to students seemed simple at first and had great motivational potential, but their implementation required student engagement, critical thinking and linking of cause-and-effect relationships in task realization, as well as collaboration. The results showed that the students adapted well to the language level and that different ways of expression on social media, which differ from formal expression in school, were not hindering factors. The creation of profiles and changing narrative perspective proved to be a challenging activity, and not all students successfully completed the task and adapted

the interaction among characters and cause-and-effect relationships. The main part of the task focused on changing the character's perspective and shaping characterizations of characters through profiles and comments, which the students did well and thus effectively connected linguistic creativity and critical thinking. In the multimodal shaping of meaning, the photographs from the Internet were used in all examples, giving them the possibility to conclude that they used the option that was simpler. The choice of photographs also showed the need to connect with the plot and key parts of the novel, and in certain tasks, the students selected photographs that did not match the time of the novel's plot.

The integration of social networks into post-reading activities enabled the achievement of learning outcomes through engaging activities and the creation of new content. The students were presented with the challenge of using new technology and new learning methods, aiming to foster creativity in the development of new content. The results indicated that the students were predominantly successful, mostly in creating linguistic elements, which they shaped independently and adapted to the language of social networks. The completion of the task also depends on the instructions given to the students, which should be clear and detailed.

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## **Challenges of Virtual Learning and Teaching Adults**

Snježana Dubovicki and Anita Kostanjčar  
Faculty of Education, University of Osijek, Croatia

### **Abstract**

Although it is an integral part of the regulation and is an indispensable part of working people, recently there is an increasing number of people of the third age who are actively involved in the process of lifelong education, most of whom are not working. Lifelong education is understood nowadays as a lifestyle, but also as a growing need of every individual, regardless of age, (un)employment, work experience.

The possibility of virtual participation in various forms of acquiring additional knowledge, skills and competences has bridged the gap between the place of residence of the participants and the place of competence acquisition. The virtual environment saved the participants additional time that they would otherwise have to take when arriving and leaving the training venue, but also provided an easier organization of current working hours.

The learner's possibilities of taking part in education are numerous in the modern era, from contact to online educational programs, training or retraining, to learning entertainment content that will satisfy the personal interests and needs of the individual. Online educational programs have contributed to overcoming the limitations imposed by the distance of the participants' residence from the place of teaching, as well as by the time limit. Although there are numerous advantages of virtual learning and teaching, it also presents a significant challenge for middle-aged and elderly people who did not grow up with modern technology that accompanies this type of education. This paper investigates the advantages and disadvantages of virtual learning and teaching using two research methods: the Focus Group method and the Causal-Layer Analysis method.

*Keywords:* lifelong education, Focus Group, Causal-Layered Analysis, virtual learning and teaching

## **Introduction**

Accelerated development, constantly decreasing prices and the increasing presence of information and communication technologies (ICT) significantly affects society as a whole, and in particular the education and the role of teachers that are constantly changing (Kruschel & Hamisch, 2019). In reviewing key government, educational and business documents that promote STEM's educational initiative, Krug and Shaw (2016) identify three dominant narratives that inform and trigger STEM policy: progress (innovation), global competitiveness (economic) and corporate (techno-capitalist) goals. The European Commission in its 2020 Strategy highlights the great need for flexible and innovative approaches to learning and methods, and points to the opportunities and benefits of ICT and other new technologies in terms of enriching the teaching process and improving learning experiences (European Commission 2015-2020).

Digitization in the modern world affects not only the development of the ICT sector, but also the development of society as a whole. Although numerous positive effects are evident, negative effects resulting from the virtual environment in education should not be ignored (Kengam, 2020; Siebel, 2019; Ulukol, 2022). The results of previous research show that students are more satisfied and motivated in classes where new technologies are used, while the experiment results show that students from both the control and experimental group scored equally in the test of knowledge, which differs from students' attitudes about new technologies affecting greater content adoption (Dubovicki and Balen, 2018).

Wheeler (in Oyaid, 2009) lists four reasons why the use of ICT in education will change the role and status of teachers: 1) ICT will provide teaching media (instruments), 2) ICT will change the way of evaluation, 3) teachers need to adapt to changes in education; 4) teachers need to better coordinate teaching with the characteristics of the human brain. This would indicate a step back from the current approach aimed at the teacher (and programme) towards an approach focused more on students. Learning becomes independent of place and time, which has a significant impact on the new understanding of education that has been far from the world within the classroom.

In comparison to the educational opportunities of only ten years ago, ICT has enabled the development of global virtual classrooms in the most diverse forms and levels, from simpler training and improvement at the primary and secondary educational level to virtual universities (Jurčević & Horvat, 2023; Kager, 2023). Yanez, Thumlert, de Castell and Jenson (2019) point out that a society which (co)exists with STEM technology becomes more competitive and

shows its progress in civilization, while on the other hand, it is evident that innovations increasingly obscure important ecological and ethical conditions and disrupt social justice.

The availability of education has substantially contributed to its democratization. Greater flexibility is enabled, it is not as time-consuming, regardless of its spatial, functional and organizational limits. Teaching for the needs of learning and teaching adults is rapidly transforming from contact to virtual. Online educational programmes are increasingly developing, and hybrid organized educational programs are also available (Kučina-Softić et al., 2021). It is still not entirely certain whether the advantages of online and hybrid classes outweigh the negative aspects of them, because despite the benefits that go with the aforementioned, there is a fear of deepening inequality in society due to the unavailability of the Internet in many rural areas. The high costs of the necessary technological equipment and the necessary IT knowledge to participate in virtual classes also contribute to the promotion of inequality in society. The transformation of business and production processes, which are happening due to the rapid development of technology and digitization, have transformed the needs of the labour market for the workers' skills. However, formal education does not follow these needs and is still insufficiently focused on STEM fields, which are essential for developing skills in demand on the labour market (Clarke, 2018). This is precisely why more and more is being invested in professional development and training through informal educational programs for adults. If we take into account all the possibilities provided by modern technology, the gap between acquired competences after formal education and real needs of the labour market is much easier to overcome due to the available educational programs for adults that are organized through virtual classes.

### **Digital transformation of adult education**

Globally, digitization has entered almost all spheres of life and is changing the way we communicate, work and learn. The digitization of education has created opportunities for the development of different learning platforms, which implies a completely new approach to learning and the organization of classes for adults. Lifelong education plays an increasingly important role in educational policies. To confirm that, there are defined national qualification frameworks and systems for validation and recognition of informal learning. The European Union has recognized the potential of technology for the development of lifelong education and the availability of education for the masses. As a result, the EU launched the Digital Education Action Plan 2018 - 2020 and has developed it continually 2021 - 2027. In the European Union, digitization in education means facing challenges such as quality improvement, individualized

access and applicability. The biggest challenge in adult learning and education is reaching those who need it the most. The percentage of people in adult education is highest among those who already have a satisfactory level of education and are integrated into the labour market. Consequently, the EU has set two strategic priorities: 1. developing a highly effective digital education ecosystem and 2. improving digital skills and competences for digital transformation (European Commission, 2020). Digital Education Action Plan 2021 - 2027 sets goals for digitization in education, which aim to provide all citizens with access to high-quality digital education, regardless of place of residence or origin, but also to encourage innovation and entrepreneurship in the education sector through digital technologies. Entrepreneurial competence, in addition to stimulating the growth of new companies, influences the development of an entrepreneurial way of thinking and more effective use of the creative potential of existing knowledge and skills. For this reason, the interest in educational programmes that encourage and develop entrepreneurial competence is increasing (Sedlan König, 2013).

The implementation of digital technology in the educational system is part of broader global policies that aim to create a digital economy of knowledge with highly qualified human capital that is trained to live in the digital age and that is able to adapt to the uncertainties of the future (Jurčević & Horvat, 2023).

#### *Digital transformation of adult education in Croatia*

Croatian efforts in the integration of digitization of education include specific measures aimed at supporting the development of a European framework for the recognition of digital skills and competences, which would enable Croatian citizens to gain recognition for their digital skills in the EU. Strategic goals include, among other things, the possibility of various forms of informal education with available free vouchers for adult education through the Croatian Employment Service (CES). Free education vouchers are available to anyone who is not a participant in formal education and/or who wants to acquire additional competencies, which has led to an increase in access to education and, consequently, to a reduction in differences in equality of access to education (<sup>8</sup>CES). The user is enabled to co-finance any educational programme that is devised according to the standard of the Croatian Qualifications Framework and is offered by the education provider which registered it in the CES Voucher system. There are currently 158 educational institutions that offer a total of 1,131 education programmes

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<sup>8</sup>See more about it at: <https://www.hzz.hr/> (accessed March 19, 2024).

registered in the database of education service providers available to users for the allocation of vouchers. 209 different educational programmes are available, 77 refer to the acquisition of digital, 46 to the acquisition of green skills and 86 to the acquisition of general skills, shown in Table 1. Availability of educational programmes through CES vouchers for education<sup>9</sup> (CES)

*Table 1. Availability of educational programmes through CES vouchers for education*

<b>EDUCATIONAL PROGRAMMES</b>	<b>Digital educational programmes</b>	<b>Green educational programmes</b>	<b>General education programmes</b>	<b>TOTAL</b>
Approved programmes	533	363	235	<b>1.131</b>

As of March 14, 2024, since the beginning of implementation, a total of 19,043 requests for education have been approved for employed and unemployed persons who have completed formal education and are not included in a higher education programme, of which 15,643 requests for acquiring digital skills, 2,609 requests for acquiring green skills and 791 requests for acquiring other skills (Croatian Employment Service, 2024). Taking in consideration the recommendations of the Digital Education Action Plan 2021 - 2027, Croatia's efforts to raise the level of digital competences of citizens who have recognized the potential of inclusion in educational programmes via CES vouchers and thus adapt to the digital transformation of the labour market are evident. Modern forms of employment imply openness to the acquisition of new skills and competences and thus availability for lifelong education.

### **Research methodology**

Qualitative methodology was used in this study. The empirical material on the basis of which the conclusions were drawn was derived from the participant observation of the discussion leader with conscious and systematic participation in the activities of the Focus Group participants. The written notes of the participants about the reflection, experience and emotions of the observed group and the notes taken by the leader of the Focus group were analysed. Research ethics were respected in all phases: from implementation, through realization to the presentation of the obtained results. Based on the previously written theoretical description, conceptualization and definitions of terms from the field of virtual and lifelong education, as

<sup>9</sup>CES vouchers for education represent co-financing of education programmes for the acquisition of digital, green and general knowledge and skills. They are available online, in a hybrid form or by contacting the CES My Voucher application. More information available at: <https://vauceri.hzz.hr/> (accessed 3/14/2024).

well as the presentation of the results of previous research on this topic, the objectives of the empirical research were formulated.

#### *Research goal*

The goal of the research is to examine and find out certain aspects of the experience, attitudes and opinions of people who have completed an online educational programme for adults, and with this in mind, to see if there is a connection between the competencies they have acquired by completing the online educational programme and the potential for growth of their competitiveness on the labour market. In relation to the stated goal, the following research questions were asked:

- 1) *Are unemployed people more competitive on the labour market after completing online educational programmes?*
- 2) *According to the participants, are online adult educational programmes of the same quality as face-to-face traditional adult educational programmes?*
- 3) *Can adults participate equally in educational programmes conducted in a virtual environment, given their digital competences?*

#### *Participants*

The research was conducted on a sample of N=12 unemployed persons who were divided into two focus groups with 6 participants in each group. In accordance with the objectives of the research, the participants were selected according to the following criteria: 1 - adults who have completed formal education; 2 - adults who have completed an online informal education programme; 3- educational level from high school educational level to higher educational level; 4 - they don't know each other.

#### *Research methods and procedure*

Two research methods from the field of future studies were used in the research: Causal layer analysis and Focus group methods (N=12), which best corresponded to the paradigm of understanding on which this methodology rests. The research was conducted from February to March 2024 among adults who were registered with the Croatian Employment Service and who completed their education in a virtual environment.

#### *Causal stratified analysis*

Causal layered analysis (hereinafter CLA) was developed by Sohail Inayatullah (1998; 1999; 2004; 2005a; 2008). It helps to create the desired future, to analyse problems, to question our conventional views of reality. The goal of CLA is not to predict the future but to create

transformative spaces for the creation of alternative futures (Inayatullah, 1998, 2005a; Dubovicki and Kostanjčar, 2023). Using the method of future studies, we investigated alternative possibilities of educational programmes for adults who have completed formal education, observing with a multidimensional approach the advantages and disadvantages of online educational programmes for adults, in the present and in the past. Contemporary teaching, as it is carried out in the present, affects the attitudes of the students and consequently affects the shaping of the vision of adult education in the future, as well as the trends, social discourses and worldviews of the society that surround us (Inayatullah, 2005b). CLA is based on four main levels of analysis: 1. Litany – studies trends and proposes visions for the future, 2. Social causes - studies and analyses qualitative data from the environment (social, economic, cultural, political), 3. Discourses and worldview - this is the level at which we investigate how worldviews from the environment lead to a situation, 4. Myth or metaphor - represent stories about the unconscious dimensions of the problem and the prevalence of data and open discussions for a deeper level of knowledge (Inayatullah, 2013). Causally layered analysis is best used in combination with other methods and by doing that also to integrate different approaches to information analysis (Dubovicki and Kostanjčar, 2024; Inayatullah, 2005b; 2013). It is for this reason that the Focus Group method was used in addition to the Causal Layered Analysis. Respecting the defined levels of Causal layered analysis, questions were created for the Focus group of respondents as shown in Table 2.

Table 2 Causal layered analysis - protocol according to CLA

Litany	Do you think that the educational institution was ready for the challenges of the virtual environment when conducting classes?
	Has online teaching had a positive or negative effect on your emotional, sociological or social aspects?
	How did you feel during the online classes?
	How do you think society generally perceives online educational programmes?
Social causes	Think about whether there are social prejudices in your environment that affect your perception of educational programmes that take place in a virtual environment.
	Consider which are the most significant elements of traditional and which of contemporary lessons. In your opinion, is online teaching based more on elements of traditional or modern teaching?
	Think about how important it is for you to have the approval of society and the confirmation of close friends and family about your education.
	What methods of delivery of educational programmes (contact, online or hybrid) is preferred by the society you live in?
	Think and write down your prejudices and opinion about online educational programmes and analyse their justification.
Beliefs (worldviews)	List your suggestions for improving online classes based on your personal experience
	Think about the <b>advantages</b> of online classes compared to contact classes
	Consider what are the <b>disadvantages</b> of online classes compared to contact classes
	Think about and list the biggest difficulties that bothered you while participating in online classes.



<b>Myth (metaphor)</b>	Indicate which educational programmes cannot be carried out in a virtual environment in your opinion. Do you think that you are as competitive in the labour market after obtaining a qualification through an online educational programme as participants who obtained the same qualification during traditional classes? Think about whether teaching in a virtual environment has met your expectations. Do you think that by participating in online classes you have acquired additional digital competencies that are necessary in a virtual environment?
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### *Focus group - sample*

Another method of future studies is the Focus group, which serves to gain extensive insight into the structure of a topic or a specific problem, and often serves to reveal or reflect personal preferences (Vrcelj & Mušanović, 2001, p. 118). The optimal number of Focus Group participants is six to eight people, and as a result, two groups of six participants were formed. The focus groups were conducted on the basis of the methodological template Causally layered analysis, which anticipated discussion in four thematic blocks: 1. Litany, 2. Social causes, 3. Beliefs - worldviews, 4. Myth - metaphor. Standpoints and predictions about online educational programmes from the perspective of adults who have completed education in a virtual environment were obtained, based on the opinions of the participants. Focus group participants are of different educational levels, age groups and social status. Group members do not know each other and did not influence each other's answers, which is also a criterion for selecting Focus Group participants (Vrcelj & Mušanović, 2001; Dubovicki, 2017, 2020; Dubovicki & Kostanjčar, 2024).

### **Research results and interpretation**

Focus group participants discussed the digitization of adult education and its effects on society. The opinions of adults based on their personal experience of participating in online educational programs according to the CLA protocol were analysed:

1) Litany:

- a. Do you think that the educational institution was ready for the challenges of the virtual environment when conducting classes?

*Ten participants of the discussion believe that the educational institution was prepared at a satisfactory level when holding classes. Two participants felt that the virtual environment could have been at a better level.*

- b. Has online teaching had a positive or negative effect on your emotional, sociological or social aspects?

*Six out of 12 participants of the workshop pointed out that they felt uneasy because of the virtual environment, especially when they had to engage in online communication.*

*They felt the most discomfort in the first days, and as the class progressed, they adapted and were more relaxed. Six participants pointed out that they missed live contact with other participants, including informal communication.*

- c. How did you feel during online classes?

*All participants pointed out that they were under stress at the beginning. They worried whether their digital competences were at a satisfactory level for active and necessary participation in classes.*

- d. How do you think society generally perceives online educational programmes? *All participants agreed that the majority of people from their environment believe that online educational programmes are of lower quality than contact classes.*

2) Social causes:

- a. Think about whether there are social prejudices in your environment that affect your perception of educational programmes that take place in a virtual environment.

*Seven participants pointed out that they are bothered by society's prejudices about the poorer quality of online educational programmes, especially since the classes were more demanding than live classes and they are bothered because society does not value their acquired qualification enough. Five participants did not pay attention to the opinion of society because their acquired knowledge is important to them, which is essential for their professional advancement.*

- b. Think about which are the most important elements of traditional and modern lessons. In your opinion, is online teaching based more on elements of traditional or modern teaching?

*The participants answered this question as a group. The first group of participants highlighted the following characteristics of traditional teaching: copying, writing down, learning by heart, memorizing. On the other hand, according to the group of participants, modern teaching is characterized by interactivity and greater equality between teachers and students. Another group of participants also emphasized the passivity of students as an element of traditional teaching and the lack of developing critical thinking skills and the ability to find the necessary information and systematize it as an element of modern teaching as opposed to rote learning, which is characteristic of traditional teaching. Both groups agreed that online teaching was developed more on the elements of modern teaching.*

- c. Think about how important it is for you to have the approval of society and the confirmation of close friends and family about your education.

*Seven out of 12 participants pointed out that it is extremely important for them to get the approval and confirmation from the society about their acquired competences from online educational programmes, and the remaining 5 stated that they are flattered by society's confirmation, but they are not burdened by it.*

- d. What methods of delivery of educational programmes (contact, online or hybrid) is preferred by the society you live in?

*Everyone agreed that the majority still prefers contact classes, but also that this is because many still have not had the opportunity to experience online classes and are therefore not even competent to make an educated judgement. They also all agreed that a hybrid form of teaching has the potential to take advantage of the best of both forms of teaching.*

- e. Think and write down your prejudices and opinions about online education programmes and analyse their justification.

*Some of the major prejudices or beliefs of the environment about online classes are: lower quality level than in contact classes, greater possibility of copying during exams, weaker motivation and/or concentration of students during classes, poorer communication between students.*

3) Beliefs - worldviews:

- a. List your suggestions for improving online classes based on your personal experience.

*The recorded proposals are: a so-called virtual corridor or a space for socializing and informal communication of students that would be available throughout the duration of classes, electronic equipment provided by the educational institution for students, which would ensure equality in participation, pre-testing of digital competences and the possibility of training before the start in order to ensure a satisfactory levels of IT literacy for those who lack it.*

- b. Think about the advantages of online classes compared to contact classes. *The advantages noted by the participants are: availability to everyone regardless of their place of residence, flexibility, easier organization of time and coordination with private and business obligations, non-stop availability of learning materials.*

- c. Consider what are the disadvantages of online classes compared to contact classes.

*The participants pointed out the following: lack of social contact, they missed*

*informal socializing with other participants, occasional interruptions in the Internet connection, weaker concentration during classes.*

- d. Think and list the biggest difficulties that bothered you while participating in online classes.

*All pointed out that the Internet connection occasionally gave them problems.*

4) Myth - metaphor:

- a. Indicate which educational programmes cannot be carried out in a virtual environment in your opinion.

*As examples, the participants cited: driver, operator of various machines, cook and other vocational education programmes where the emphasis is on practical education.*

- b. Do you think that you are as competitive in the labour market after obtaining a qualification through an online educational programme as participants who obtained the same qualification during traditional classes?

*All participants believe that they are just as competitive in the labour market as the participants of the same live programmes, and especially the participants of IT online education programmes.*

- c. Think about whether teaching in a virtual environment met your expectations. *All agreed that the online education programme met their expectations.*

- d. Do you think that by participating in online classes you have acquired additional digital competencies that are necessary in a virtual environment?

*All are certain that participation in online educational programmes has contributed to their digital competences.*

Taking in account viewpoints of the Focus Group participants, they all agreed that participation in online classes contributed to raising their level of digital competence and thus made them more competitive on the labour market. 52.33% of participants believe that the society has prejudices about the poorer quality of online education programmes, but despite this, considering the needs of the labour market, this is not an obstacle for them to find the desired job, which gives us the answer to the 1st research question - *Are unemployed people, who have finished an online education programme, more competitive on the labour market?*

100% of Focus Group participants believe that online educational programmes follow modern trends because they are developed more in line with the characteristics of modern teaching and are therefore of higher quality than educational programmes that are conducted exclusively live

while respecting traditional teaching elements, which gives us the answer to the 2nd research question - *Are online education programmes for adults, according to the participants, of the same quality as contact traditional education programmes for adults?*

Also, all research participants (100%) agreed that it is necessary to check the level of digital competences of participants before joining online educational programmes and to provide pre-enrolment instruction to those who need it, so that everyone has the necessary IT knowledge. In this way, equal participation in classes would be ensured for everyone, which gives us the answer to the 3rd research question - *Can adults participate equally in education programmes that are conducted in a virtual environment, considering the digital competences they possess?*

## **Discussion**

Online teaching plays an increasingly significant role in the education of adults, especially in education programmes where the practical part of learning is not in focus. Although the virtual environment has numerous disadvantages, based on the experiences of the participants of the Focus Group, numerous advantages are evident, but there are also challenges which are still the subject of discussions for the future and development of adult education in the virtual environment. High costs are one of the main disadvantages of using virtual classes, but also the time needed to learn and master ICT skills, possible health and safety disadvantages due to the protection of personal data and exposure on the Internet (Pantelidis, 2010). It is certainly necessary to have prior knowledge in usage of ICT, which is especially a problem for middle-aged and elderly people. There is also a noticeable lack of social inclusion, which leads, in addition to missing communication skills, to a reduced ability to recognize non-verbal communication due to a lack of spontaneous interpersonal interaction. By increasing the virtual environment in education, there will be less and less personal interaction, and on the other hand, even greater dependence of students on technology (Kengam, 2020). All participants of the Focus Group pointed out that it is more difficult to maintain motivation and concentration during online classes, which can consequently affect people who do not have a developed habit to study regularly, and thus the learning outcomes will be questionable, as well as the success of completing the educational programme. The authors agree that increasing exposure to the Internet and social media contributes to changes in interpersonal relationships and reduced empathy (Kengam, 2020; Jurčević & Horvat, 2023). Consequently, it is important to develop emotional intelligence and the so-called "soft skills" that are neglected in the virtual environment.

There are certainly significant advantages of online education programmes, which all participants of the Focus group pointed out, some of which are the availability of a wide selection of programmes regardless of residence and place of teaching, saving time and money that would have to be spent on travelling to lectures. Flexibility is another benefit that everyone emphasized, especially due to the possibility of choosing the pace and time of study that best suits each individual. By participating in virtual educational programmes, all of them pointed out an important benefit, the improvement of digital competences, which they probably would not have achieved or improved on their own if they had not been forced by the need to participate in online classes. Participants who are more introverted by nature pointed out that the virtual environment enabled them to participate and communicate more freely and equally since they did not have to "fight for the word" and thus they got the opportunity to stand out and achieve better results.

Methods from the field of futures studies, which were used to obtain the above results, play a major role in the research of this issue and in the preparation of possible future scenarios (Inayatullah, 2013; Dubovicki, 2017, 2020; Beara and Dubovicki, 2023).

### **Concluding considerations**

Based on the analysis and definition of the characteristics of virtual learning and teaching of adults as one of the important segments of approaching the labour market and competitiveness and implementation in education research, it is possible to offer certain conclusions. In the near future, it is very certain that traditional education will be completely abandoned, because as such it will certainly not be able to adequately prepare students for the challenges and demands of the labour market in the future, but also for many other aspects of life that await us in the future and are increasingly intertwined with virtual reality. Many enthusiasts believe that the digital transformation of the world will bring numerous advantages, but in parallel with them, many warn that one should be careful with the implementation of modern technologies in the education system, primarily because of possible negative consequences.

The study offers inductive and analogical conclusions based on the conceptualized theoretical premises of the researched topic, the results of previous research and the obtained results of this empirical research.

The change of the scientific research paradigm and the implementation of methods from the field of futures studies in the research corpus gives additional significance in the approach to this type of research by offering a redefinition of existing theories and concepts.

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## **Digital And Assistive Technology In An Inclusive Classroom - A Teacher's Perspective**

Aleksandra Krampač-Grljušić<sup>1</sup>, Marija Iličić<sup>1</sup> and Natalija Lisak Šegota<sup>2</sup>

<sup>1</sup>Elementary school “Ljudevita Gaja”, Osijek, Croatia

<sup>2</sup>Faculty of Education and Rehabilitation Sciences, Zagreb, Croatia

### **Abstract**

Nowadays, digital technology is developing rapidly and has a strong and diverse impact on humanity. It is also being used in the education system, improving and changing it and having an impact on students. The digital technology that has developed and facilitated communication, coping and promoting the independence of children and people with disabilities, is called assistive technology. Assistive technology is used to maintain or improve the functional abilities and greater independence of children and people with disabilities and to promote their well-being.

Digital and assistive technologies have become part of the daily lives of students and teachers, and their use in the classroom is mandatory and prescribed in the national curriculum for primary school (MZOS, 2017).

The aim of this paper is to gain insight into the opportunities and barriers to the use of digital and assistive technologies in the work of teachers in an inclusive primary school. The data was collected using the focus group method and was analysed using thematic analysis as a form of qualitative data analysis. The sample was intentionally non-probabilistic and included twelve primary school teachers (divided into 2 groups) in the city of Osijek.

The data collected provides initial insights into teachers' perspectives and experiences of using digital and assistive technologies when working with students in an inclusive classroom. The benefits are highlighted, but the challenges of use are also recognized, along with recommendations for improving the implementation of digital and assistive technologies in the inclusive education system.

*Keywords:* digital and assistive technology, teacher's perspective, classroom teaching, inclusive environment

## **Inclusive education and inclusive design for learning**

The comprehensive definition of inclusive education includes various prerequisites and criteria that should be met for the successful realization of inclusion without discrimination and based on equal opportunities. Above all, this means that values and beliefs that accept diversity as an integral part of human diversity and enable every child to have the right to education and to acquire competencies, knowledge, and skills for an independent life should be respected (United Nations, 2006).

The authors Göransson and Nilholm (2014), based on a review of the literature between 2004 and 2012 in the field of inclusive education, summarize various definitions of this concept and point out that inclusive education is defined in three different ways. First, the inclusion of a child with difficulties from special educational circumstances into a mainstream school system. Second, inclusion as meeting academic and social needs of children with disabilities through the necessary forms of professional support for them. And third, inclusion as realizing academic and social potential of every child in the education system, achieving universal design for learning in the broadest sense (Krischler et al., 2019).

Inclusive education is a holistic approach that considers the needs of all students while adapting content and working methods, methods of knowledge transfer and assessment, creativity and cooperative learning, and the use of different tools and technologies to meet diverse needs. Inclusive education ensures socio-emotional benefits, academic achievement, personal growth and development, and the creation of a climate of tolerance and respect for diversity (Krampač-Grljušić et al., 2022).

The prerequisites for successful inclusion are therefore based on ensuring appropriate adaptation and accessibility, the use of digital and assistive technologies in the classroom and providing support for children with disabilities, for every student in the classroom, in accordance with the principle of universal design for learning. This requires inclusive legislation and the implementation of the philosophy of inclusion in schools. If society does not support inclusion financially, it will be impossible to achieve quality standards for inclusion. Financial resources are important for the training of qualified teachers and professionals working in schools, for the implementation of accessibility and the adaptation of school buildings and interiors, for the installation of lifts and platforms, for the acquisition of digital and assistive technologies to make all curricular and extra-curricular content accessible, and for the procurement of didactic material for individualization.

It is important to support teachers in their work, e.g. through multidisciplinary and transdisciplinary collaboration, and specialized training in the application of specific

knowledge and skills in the use of different types of technology. Also, team meetings with the expert team at the school level and with teachers and teaching assistants, who should be the link between children with disabilities and their classmates in the classroom, are important. The assistants should support each student in the classroom and ensure social relationships in an inclusive classroom, student autonomy and collaboration with teachers in implementing inclusion and an individualized approach for each child (Tews & Lupart, 2008).

If a teacher does not have sufficient knowledge of the student's individual characteristics, they cannot intervene to provide support and ensure an individualized approach. Theoretical knowledge and practical experience of teachers and school experts are important predictors of the quality of integration. Mutual exchange of experience through evidence-based knowledge and examples of good practice in schools (Van Velzen et al., 2012) helps to reinforce the strengths of all education professionals.

Specific knowledge about students with disabilities contributes to the individualization of the teaching process in accordance with the child's needs and interests. Ensuring adaptation and accessibility for children with disabilities is the path to inclusive learning design. If we think in advance about all the adaptations and accessibility that need to be provided for a particular difficulty, then we ensure that every child can participate in the teaching process and can benefit from a learning design that takes diversity in the classroom into account.

Inclusive design for learning includes every child and is explained by three dimensions. Every child is valuable, and teachers should teach children to discover their own uniqueness and specialness and to respect these specialties in other children. Education and teaching process itself should be inclusive, more specifically. It is a learning process that supports the right to expression and appreciation, active participation, teamwork, collaboration and sharing of experiences among students. Through the education system they strive to change the culture of reflection and to think globally and locally, considering the well-being of all, all countries, people, the planet and all living beings (Watkins et al., 2020; Treviranus, 2018).

The "Guide to Inclusive Design for Learning" lists valuable resources that can be used to create an inclusive learning environment that incorporates a variety of technologies and media and can be found on page seven in the source by authors Watkins et al. (2020).

Next chapter focuses on explaining digital and assistive technology and their valuable role in the process of inclusive education.

## **Digital technology in the education system**

Digital technology encompasses any product that can be used for creating, viewing, transmitting, generating, storing, trading, downloading, sending, and receiving information in digital form (Gaković, 2020). Its continuous and rapid development aligns with society's need for greater digital competencies and knowledge across individuals of different ages, backgrounds, and occupations (Croatian Academic and Research Network (CARNET), 2018). Digital technology is rapidly evolving, with multiple influences on humanity, significantly impacting children, their growth, and development (Ružić & Dumančić, 2015). Today's children and students are constant users of digital technology, spending a lot of time using digital technology to play and entertain themselves (Mezak, 2020). Therefore, digital technology plays a significant role in their daily lives, including education (CARNET, 2018).

Education system has been transformed by the introduction of digital technology (Gaković, 2020). Digital technology is an inseparable element of modern learning and teaching methods and should serve students by enabling learning through exploration, problem-solving, project-based, collaborative, and game-based learning (CARNET, 2018a). It is important for students to recognize the benefits and challenges of using digital technology and understand how it affects personal and social development and their health (Mezak, 2020). Benefits can be realized if the use of modern technology is purposeful, targeted, and age-appropriate for students. By establishing the right system of values and boundaries, potential challenges associated with digital technology can be avoided (Rogulj, 2013).

Teachers need to seek new teaching methods, so they should acquire new competencies in digital literacy and active use of digital technology with self-education and professional development (Mezak, 2020). Teachers need to understand that the application of digital technology should always aim to further improve the teaching process, focusing on the students and their activities under their guidance (CARNET, 2018a).

Besides improving the teaching process for regular student's development, digital technology greatly aids and supports students with disabilities. It enables teachers to better impart knowledge and aids students with disabilities (Gaković, 2020).

A type of digital technology that has developed is called assistive technology. Assistive technology can facilitate easier communication and movement and encourages greater independence of children and people with disabilities.

## **Assistive technology**

Assistive technology is defined as any item, piece of equipment, or system of products, whether acquired commercially, modified, or customized, that is used to increase, maintain, or improve the functional capabilities of individuals with disabilities. The World Health Organization describes assistive technology as any product, instrument, equipment, or technology adapted or specially designed to meet the needs of individuals with disabilities related to cognition, communication, hearing, mobility, vision, and self-care. Assistive technology contributes to the well-being and improvement of individuals, their health, and their inclusion and participation in family, community, and all areas of society, including political, educational, economic, and social spheres. It enables individuals with disabilities to lead productive, independent, and dignified lives (Vukušić, 2016).

### **Categorization and classification of assistive technology – division**

Several types of categorizations and classifications facilitate finding the appropriate assistive device according to individual needs. The Iowa Center of Assistive Technologies (2016) lists the categorization of assistive technologies based on their purpose: 1. positioning, 2. mobility, 3. augmentative and alternative communication, 4. computer access, 5. adapted toys/games, 6. adapted environment and 7. teaching aids.

The positioning includes devices that enable achieving and maintaining the correct body position for performing specific activities (e.g., adapted chairs and tables) (Vukušić, 2016). Mobility refers to devices that facilitate and enable mobility for individuals with disabilities (crutches, orthoses, walkers, etc.). Augmentative and alternative communication devices provide support in communication and stimulate the development of communication skills (e.g., communicators). Devices for easier access such as adapted keyboards and mice, are used to enable individuals with disabilities to be independent and use computers. Adapted toys (sensory boards, sound and tactile toys) and games for children with disabilities enable exploration and the development of social and cognitive skills. Environmental adaptation involves organizing the environment to facilitate independent living, education, work, or leisure activities (e.g., infrastructure adjustments to buildings, workplaces, and the environment) (CARNET, 2018b). Teaching aids enable students with disabilities to follow the teaching process more easily and participate more effectively. Some examples include various teaching aids, audiobooks, educational applications, content, and other (Vukušić, 2016).

Regarding categorization by purpose, assistive technology can be classified according to the level of technology required for use. It is important to emphasize that assistive devices can be simple items that do not require power or special training to use but fulfil their purpose

and objective. The Iowa Center of Assistive Technologies (2017) categorizes assistive technology based on the level of technology required for use as follows: 1. no-tech, 2. low-tech, 3. mid-tech, 4. high-tech.

In the "no-tech" classification, items, services, and environmental conditions that do not require special systems, devices, or equipment but enable students with disabilities to perform activities independently are included. Examples include pencil grips, writing templates, coloured papers, embossed paper, custom-made communication books, visual schedules, extended time for task completion, and others. "Low-tech" devices are low-technology devices that do not require power but may require minimal education. Some examples of "low-tech" devices are adapted eating utensil holders, customized chairs, glasses, canes or walking sticks, magnifiers, and prescription glasses. Relatively more complex devices that may require power and specific knowledge or education but do not contain sophisticated electronic systems belong to the "mid-tech" classification. In this group, customized keyboards, wheelchairs, and other are included. The most sophisticated level of assistive technology is "high-tech," which encompasses high-tech devices based on computer systems, involving sophisticated computer programmes, and requires additional knowledge or education (Čunčić, 2018).

When selecting appropriate assistive technology, a team of experts, including teachers, is needed, and based on a professional assessment of individual student needs, suitable assistive technology is chosen (CARNET, 2018b).

### **Assistive technology in education system**

Assistive technology is used and necessary in education. It enables students with disabilities to communicate with teachers, other students, and their environment. It provides support in expressing thoughts, feelings, desires, and needs. However, it facilitates their acquisition, processing, and exchange of information and educational material. There is significant importance in the increasing implementation of assistive technology in the education of children with disabilities because it allows complex educational material to be presented in a simple way and meets the individual needs of students with disabilities. It is essential to ensure continuous support, motivate teachers to cope with changes in digital and assistive technology, and encourage them to focus on the possibilities that these technologies can offer in working with students. The skills and attitudes of teachers determine the effectiveness of integrating technology into the curriculum. To enable meaningful implementation of digital and assistive technology and to support and improve learning, teachers' perspectives and beliefs should be considered (CARNET, 2018).

## **Aim and research questions**

The aim of this qualitative research is to gain insight into the opportunities and barriers to the use of digital and assistive technologies in the work of teachers in an inclusive primary school.

Based on the aim of the study, the following research questions were formulated:

- 1) What opportunities are there for the use of digital and assistive technologies in the work of teachers in an inclusive primary school?
- 2) What are the obstacles to the use of digital and assistive technologies in the work of teachers in an inclusive primary school?
- 3) What suggestions do teachers have for improving teacher training and implementing the use of digital and assistive technologies in an inclusive primary school?

## **Methods**

### *Participants*

In this study, a purposive sampling method was used to select the study participants. The study participants were teachers from an inclusive primary school in the city of Osijek.

The study involved 12 primary school teachers. All participants were female, with 25% of them aged between 21 and 30 years, 8.3% aged between 31 and 40 years, 16.7% aged between 41 and 50 years, 33.3% aged between 51 and 60 years, and 16.7% of the participants were over 61 years old. The participants varied in terms of their length of teaching experience. Specifically, 25% of participants have up to five years of experience, 8.3% have between five and 14 years of experience, 41.7% have between 15 and 34 years of experience, and 16.7% have more than 35 years of experience. Experience of working with children with disabilities varied between 25% of participants with up to five years of experience, 8.3% with 5-15 years of experience, 47% with 15-30 years of experience and 19.7% with more than 30 years of experience of working with children with disabilities in inclusive schools. In addition, almost all participants, namely 91.7 % of them, had completed further training for working with students with disabilities. All participants have experience with training on the use of assistive technology in the school environment and 60% of them feel confident in using assistive devices in practice, 25% of them still need support in implementation and 15% of them stated that they need further training. Most teachers, 80% of them, have been using assistive technologies for five years and 20% of them have more than five years of experience in using assistive technologies in their professional activities.



### *Data collection process*

The focus group method was used to collect qualitative data. The protocol for the focus groups was developed based on the aim of the study and the research questions. The protocol included initial discussion questions related to the main areas of research interest in the implementation of digital and assistive technologies for inclusive learning approaches. There was also an opportunity for the teachers themselves to contribute new discussion topics based on their experience.

To ensure ethical principles throughout the research process, the Code of Ethics for Research in Science and Higher Education (Committee of Ethics for Research in Science and Higher Education, 2006) was followed. Before the research was conducted, participants were informed about the aim of the research and the research itself and familiarized with their rights by signing the researcher-researcher agreement. Particular attention is given to the voluntary participation of the participants in the research and to the confidentiality and anonymity of their data.

### **Thematic analysis**

In this study, thematic analysis was used as a form of qualitative data analysis. The coding steps in the thematic analysis are open coding, in which the participants' statements are converted into codes, followed by searching for the topics covered by the coded data and within the research themes, and finally forming appropriate sub-topics in terms of peculiarities or similarities in meanings (Braun & Clarke, 2006). Based on the qualitative data analysis, the answers to the aim of the study and the research questions were given.

### **Results and discussion**

Based on thematic analysis (Braun & Clarke, 2006), the main themes and subthemes were identified using codes. Codes are the basic units of analysis that answer the question: "*What is the most important thing the participants tell us?*". The analysis process was organised in Table 1. in which the main topic and subthemes were explained by the codes.

**Table 1.** Types of assistive technologies used in teachers' work; opportunities and challenges for the use of assistive technologies from the teachers' perspective; education/training that teachers have experienced and teachers' suggestions for improving the training and the use of assistive technologies

THEMES AND SUBTHEMES	CODES
<ul style="list-style-type: none"> <li><b>TYPES OF ASSISTIVE TECHNOLOGIES USED BY TEACHERS</b></li> </ul>	
<b>Technologies by categories</b>	
<b>Positioning</b>	<ul style="list-style-type: none"> <li>Adapted chairs and tables; pilates balls; circular pads for more correct sitting</li> </ul>
<b>Customised environment</b>	<ul style="list-style-type: none"> <li>Adaptation of spatial conditions for children with visual impairment</li> </ul>
<b>Custom games</b>	<ul style="list-style-type: none"> <li>Sound toys for children with hearing impairment; tactile toys for visually impaired children</li> </ul>
<b>Teaching aids</b>	<ul style="list-style-type: none"> <li>Adaptation of writing paper and drawings; relief maps; inserts and calculators; digital tools and various educational applications for developing knowledge and skills; audio books; pencil holder; reading order tracking aid</li> </ul>
<b>Technology by classification</b>	
<b>No - tech</b>	<ul style="list-style-type: none"> <li>Inserts and calculators; embossed folders and embossed globes; enlarged textbooks and work materials; pencil holder; notebooks with enlarged drawings and contrasting background</li> </ul>
<b>Low - tech</b>	<ul style="list-style-type: none"> <li>Adapted chairs; magnifying glasses and prescription glasses for visually impaired students; sound balls</li> </ul>
<b>High - tech</b>	<ul style="list-style-type: none"> <li>Projectors; computers; interactive boards; tablets; voice recorder</li> </ul>
<ul style="list-style-type: none"> <li><b>OPPORTUNITIES FOR THE USE OF TECHNOLOGY</b></li> </ul>	<ul style="list-style-type: none"> <li>Facilitating the acquisition of knowledge</li> <li>Encourage children's motivation to work</li> <li>Encourage children's interest in work</li> </ul>
<ul style="list-style-type: none"> <li><b>CHALLENGES IN THE USE OF TECHNOLOGY</b></li> </ul>	<ul style="list-style-type: none"> <li>Problems with the quality of the Internet network</li> <li>Slow technology due to obsolescence</li> </ul>

	<ul style="list-style-type: none"> <li>• Stress for teachers due to encountering the new and unknown</li> <li>• Unpredictability in the use of technology</li> <li>• Frequent technology failures</li> </ul>
<ul style="list-style-type: none"> <li>• <b>EDUCATION/TRAINING IN WHICH TEACHERS WERE INVOLVED</b></li> </ul>	
<b>Topics of the education/training</b>	<ul style="list-style-type: none"> <li>• Technology for visually impaired children</li> <li>• Learning sign language with the help of technology (digital visual and video tools)</li> <li>• Technology and children with autism spectrum disorders</li> <li>• A range of digital tools in the teaching process</li> <li>• Use of digital technology in working with children with different types of disabilities</li> </ul>
<b>Organizer/s of education/training</b>	<ul style="list-style-type: none"> <li>• Vinko Bek Centre for Education</li> <li>• Association of the deaf and hard of hearing</li> <li>• Centre for Autism</li> <li>• CARNET- Croatian academic and research network</li> <li>• Agency for Education</li> <li>• Inclusive primary schools where teachers work</li> </ul>
<b>Usefulness of education/training</b>	<ul style="list-style-type: none"> <li>• Examples of good practise and the use of digital and assistive technologies in daily work with children</li> <li>• Acquiring new knowledge and skills about digital and assistive technologies</li> <li>• Use of practical examples in the classroom</li> </ul>
<ul style="list-style-type: none"> <li>• <b>RECOMMENDATIONS FOR IMPROVING EDUCATION, TRAINING AND THE USE OF TECHNOLOGY IN SCHOOLS</b></li> </ul>	<ul style="list-style-type: none"> <li>• The need for systematic and continuous education of teachers</li> <li>• The need to introduce technology education for parents and children</li> <li>• Ensure better quality of technology and technical support</li> <li>• Ensure continuous and up-to-date education</li> </ul>

The research findings show that teachers in inclusive primary schools use digital and assistive technologies in their work. The types of assistive technologies they use vary by category (Viner et al., 2020; Vukušić, 2016) and classification (Čunčić, 2018) from no-tech,

low-tech to high-tech. Teachers use a customised environment, games and teaching aids. For positioning, they use adapted chairs and tables, pilates balls and round cushions for correct sitting. The environmental adaptation mainly refers to adaptation for blind and visually impaired students. The acoustic toys are used for hearing impaired students and the tactile toys for blind and visually impaired students. Teaching aids used include paper and drawing adaptation for writing, relief maps, abacuses, calculators, digital tools, various educational applications for knowledge and skills development, audiobooks, pencil grips, and reading order aids.

Teachers use the following examples of no-tech technology: abacuses and calculators, relief maps and globes, enlarged textbooks and work materials, pencil grips, and notebooks with enlarged lines and contrasting backgrounds. When it comes to low-tech technology, they use adapted chairs, magnifiers, prescription glasses for visually impaired students, and sound balls. As for high-tech technology, they use projectors, computers, interactive boards, tablets, and voice recorders.

These technologies are good examples of the implementation of an inclusive learning concept in the work with students with disabilities. International studies also point to the importance of digital and inclusive tools for applying an individualised approach when working with individual students and for an inclusive universal design for teaching that considers the differences between students (Sparks, 2019; Westwood, 2018).

The use of technologies for children with visual and hearing impairments, for example, is an excellent way to realise interactive learning by integrating different learning styles such as auditory, visual, and tactile. Other studies (Volpe & Gori, 2019; Gori, 2015; Stoffers, 2011) speak of the importance of applying a multisensory teaching method and the use of technologies for the purpose of quality education in inclusive schools. The interactive teaching method has proven to be effective for students' academic success, motivation and perseverance, which is also confirmed by other studies (Chafiq et al., 2023; Pershukova et al., 2023; Tarigan et al., 2022). Inclusion means using different methods and approaches in teaching and assessment that involve every child and respond to their specific needs. Shaping the educational environment according to the principles of universal design means developing and implementing flexible learning processes that can be used by as many people as possible (United Nations, 2006).

In addition, teachers described some of the benefits and challenges of using technology when working in inclusive settings. The main benefits they emphasize are facilitating the acquisition of knowledge, the contribution to students' motivation to work and encouraging students' interest in their work (*"Technology is close to the students and interesting for them."*;

„It is a good motivator and increases the students' interest in acquiring knowledge"; „Technology facilitates and accelerates the acquisition of knowledge.”). The main challenges concern the quality of the technology, technical problems as well as the technical skills of the teachers (“The disadvantages of our technology are, firstly, that it is outdated. Secondly, it works badly. Thirdly, we have a very weak internet.”; “I get very stressed when I use technology because I am afraid it will stop working.”; „There are often sudden failures of technologies that are outdated for us.”; “There is a lack of technical knowledge to use some modern technologies because we also need support.”). Above all, the lack of familiarity with new modern technologies and the need for training in this area (“I think we really need further education in the use of assistive technologies, technology is changing very quickly so we need to have more confidence.”).

Authors Parette and Scherer (2004) talk about the challenges that people who use assistive technology may face that are associated with 'social stigmatization'. They said that while assistive technology can enhance the abilities of people with disabilities, it can also lead to social judgement, misunderstanding and prejudice, which can lead to embarrassment, self-consciousness and being perceived as different or less able (Zwarych, 2023). Authors Ayon and Dillon (2021) also speak of disadvantages related to knowledge and experience of using assistive technology in the classroom, including the roles of teachers, students, and stakeholders, as well as general educational policy and practice.

The lack of school resources is one of the significant barriers to the implementation of digital technology (CARNET, 2018). One of the biggest challenges in introducing digital technologies into the education system is the financial resources of schools in the Republic of Croatia. Due to insufficient financial resources, most schools are not able to fully equip their classrooms with digital technology (Gaković, 2020). In addition, many schools only have minimal technical support for the use of digital technologies. Difficulties also arise from curricula that are not designed to integrate digital resources into the teaching process. Teachers' lack of or low computer skills can also significantly hinder the integration of digital technologies into the classroom (CARNET, 2018).

Teachers have been trained in supporting the blind and visually impaired, learning sign language using technology (digital visual aids) and working with technology and children with autism spectrum disorders. They have also gained some knowledge about the use of digital tools in the classroom and the use of digital technology when working with students with complex educational needs. The organizers of this education were centres and associations in the local community, e.g., Vinko Bek Centre for Education, Association of the Deaf and Hard

of Hearing, and the Autism Centre; the Croatian Academic and Research Network - CARNET; the state Agency for Education and the inclusive primary school where the research participants are employed.

According to the national curriculum (Ministry of Science and Education (MZO), 2017) for the integration of digital and assistive technologies in education, the significant synergy of the different actors in the provision of knowledge in this area is important. The example of teachers' experiences in education shows the collaboration of three sectors, the education sector, non-governmental organizations and institutional support networks in the field of technology.

Examples of synergies and partnerships in implementing inclusion using modern technologies are described as a unique holistic approach to creating high-quality inclusive design in schools (Charania & Davis, 2016).

Teachers also make several recommendations to improve the use of technology in schools, such as better quality of technology and technical support (*“We need better quality technology and moderation...and support.”*; *“We are not satisfied with the quality of technology and believe that we need better quality technology so that we can provide quality teaching with technology.”*), as well as the importance of continuous education in this area through innovative insights (*“I need to educate myself, technology is changing too fast and I need support, someone to ask when something does not work”*). They also point out that in addition to the systematic training of teachers, the introduction of training for parents and pupils (*“Continuous education of teachers, students and especially their parents, as some are not aware of the negative consequences of excessive use of technology.”*) is also very important for the quality of the use of assistive technologies. This is also referred to in the UNICEF publication (2022) *“The Use of Assistive Technology in Classroom: A Guide for Teachers and Schools”*.

Computer skills and knowledge of digital technologies are not yet an integral part of formal teacher education. Teachers also complain about the lack of opportunities to develop digital skills. The fact that teacher education for the use of digital technologies is relatively poor was also emphasized by the author Gaković (2020). It is crucial to provide continuous support, motivate teachers to engage with technological changes and encourage them to focus on the opportunities that technology can provide for them and children with disabilities.

It would be very important for teachers to be obliged to familiarize themselves with inclusive learning approaches during their formal education and to incorporate them into the teaching process.

## **Conclusion**

The results of this study provide initial insights into the experiences with the use of digital and assistive technologies in inclusive schools, the benefits and challenges of their use and recommendations for improving the quality of implementation and are limited to the example of one inclusive school. The legislative framework recommends and prescribes the use of digital and communication technologies in education in an efficient, appropriate, timely, responsible, and creative manner in all subjects and areas and at all levels of education, based on the National Curriculum for Primary Education (MZO, 2017).

There is also an obligation to provide systematic education in the use of digital and assistive technologies in schools, as a complement to the basic skills that teachers should acquire as part of their academic education. Computer-assisted teaching and learning contributes to the development of students' digital, information, computer, and media skills. The school environment should ensure that everyone can use digital technologies on an equal footing and with equal value (MZO, 2017).

Furthermore, inclusive schools are precisely the places where the use of digital and assistive technologies merges with the principles of inclusive learning design. Every school should be inclusive, but the schools that have extensive experience with inclusion of students with disabilities are often the most advanced when it comes to integrating inclusive approaches that rely on modern technologies. Therefore, these schools can serve as a model for developing inclusion by utilizing digital and assistive technologies to meet the needs of all students.

In terms of future research on this topic, it would be worthwhile to investigate the perspectives of school leaders, school professionals, parents and students, as well as researchers working on this topic and policy makers, to gain a better understanding of the context and, consequently, a better quality of implementation of digital and assistive technologies in the education system.

Promoting a constructive debate on this topic and taking into account different experiences and scientifically based contemporary knowledge could significantly improve the quality of education according to the principles of inclusion, universal design and the use of modern technologies.

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## Digital Resources As An Incentive For Teacher Development

Ana Maria Marinac<sup>1</sup> and Ana Mirosavljević<sup>2</sup>

<sup>1</sup>Doctoral Researcher at Doctoral Study Programme Pedagogy and Contemporary School Culture,  
Faculty of Humanities and Social Sciences, University of Osijek, Croatia

<sup>2</sup>Department of Social Sciences and Humanities, University of Slavonski Brod, Croatia

### Abstract

In the modern digital era, online or digital resources are increasingly becoming crucial for the professional development of teachers. Over the past few years, there has been a noticeable growth in diverse online approaches to improvement, including online education, courses, and digital platforms that provide diverse content. This paper is based on a systematic literature review to illustrate the impact of the growing trend of using online resources as a stimulus for the professional development of teachers, serving as a catalyst for enhancing their knowledge and skills, as well as fostering interconnection and collaboration among them. The research will particularly focus on identifying the advantages and challenges teachers face during their participation in online training and analyse the influence of such an approach on teacher motivation. Furthermore, the paper will emphasise the importance of adapting traditional models to new trends in professional development. All these aspects aim to contribute to a deeper understanding of the role of online resources in the development of the teaching profession, providing insights into the opportunities that digital education offers for the teaching profession in the 21st century. In a broader context, the general importance of teachers' professional development will be highlighted as a crucial factor in maintaining high education standards. Through continuous investment in professional development via online resources, teachers acquire the necessary knowledge and skills essential for effective teaching.

*Keywords:* online professional development, professional growth, teachers

## **Introduction**

In the modern digital era, in which technological progress continuously transforms the ways in which we communicate, learn and work, the role of online resources is becoming more and more important, especially in the context of professional development of teachers. Observing this trend, one notices the dynamic growth of diverse online approaches to training, which often includes traditional forms of education and seminars, but also innovative digital platforms that provide a wealth of content and interactive tools. This work seeks to deepen the understanding of the increasingly present dynamics of the professional development of teachers supported by information and communication technologies. Using the existing relevant professional and scientific literature, emphasis is placed on identifying the advantages and challenges of online teacher training. Special attention was paid to the importance of adapting traditional education models to new trends. Given the speed of technological change and the constant evolution of pedagogical approaches, it is important to ensure that teachers have access to relevant tools and resources that support their ongoing professional development. Through this paper, the importance of these adaptations is highlighted and it explores how digital education can promote the advancement of the teaching profession in the 21st century. More broadly, the emphasis is on the general importance of teacher training as a key factor in ensuring a high standard of education. Investing in professional development through online resources enables teachers to acquire the necessary knowledge and skills needed to face the challenges of modern education and to achieve excellence in their work. The contribution of this work, among other things, will be a better understanding of the role of online resources in shaping the future teaching profession.

### **Contemporary approaches to the professional development of teachers - digital tools, technologies and online access**

In the last twenty years, increasing importance has been given to online forms of learning, stimulated by the progress of information and communication technology and the expansion of the availability of such technologies. The concept of e-learning appeared for the first time in 1999 at seminars on computer systems in Los Angeles, after which concepts such as online learning, distance learning, virtual learning and the like were developed. It is important to note that e-learning evolved from distance learning, implying that it existed even before the advent of the Internet. The originator of distance learning was the English professor Isaac Pitman who, in the 1840s Great Britain, began to correspond with his students, sending

them assignments that they would return. After him, many other experts contributed to the development of e-learning. The period from 1994 to 1999 is considered the first wave of e-learning, while from 2000 there is a second wave of e-learning, marked by significant technological changes that also resulted in changes in the way of learning (Celizic & Zovko, 2021).

The time in which we live is accompanied by extremely large and accelerated technological progress, and as already stated earlier, teachers have the task of responding very quickly to everything that develops and changes in order to transfer the necessary knowledge to their students and to prepare them for further education or work. Digital tools have become ubiquitous, both in classes and in professional training. Professional development is much easier thanks to rapid technological progress and the availability of professional and scientific materials. Numerous teachers around the world recognize professional development through digital tools as extremely valuable, and additional benefits are cost-effectiveness, breaking down cross-border, time and location barriers. It can be said that teachers have the opportunity to be connected with almost the whole world, learning from the world's best examples. Digital tools and technologies contribute in different ways to the possibilities of training, thus making it accessible to almost everyone (European Commission, 2018), and one of the approaches that is quite prevalent is the online approach. Since the modern teacher is constantly developing his digital competences and digital literacy, Fernandes et al. (2020) point out that it is precisely online professional development that enables the development of teachers' digital competencies. By analysing the research conducted with Portuguese teachers, it can be concluded how important continuous knowledge acquisition and lifelong learning are to support students for development in the field of information and communication technology from an early age (Pinto et al., 2016). If it is taken into account that numerous higher education institutions have recognized online learning as a very effective and sustainable way of education (Mancilla et al., 2020), such an idea is also supported by people with disabilities (Arpaci, 2015), and Guilbaud et al. (2021) point out that the majority of their success is due to digital tools, along with, of course, the teacher.

Teachers tend to be lifelong learners. Lifelong learning includes any form of learning during life with the intention of improving knowledge, skills and competences in the personal, civic, social or professional context of an individual (Agency for Vocational Education and Adult Education, 2023). Teacher education and training are important issues and policies of the European Union whose goal is to improve the education system and bring it closer to every citizen. Such a policy brings the concept of lifelong education and continuous professional

development. The goal of such an approach is the development of the educational system, but also of society in every member state of the European Union. For many years, the Council of Europe has enabled teachers from member countries to participate free of charge in multi-day European professional training in the form of seminars and workshops. After 2006, the training programme was modernised, changing the name of the programme to the "Pestalozzi Programme". Modular training for more experienced professionals and a 10-day summer school are well-known, and as additional support and a new form of training, an online portal for communication and cooperation of teams involved in the training programme was introduced. The "Pestalozzi Programme" is important when talking about the professional development of teachers because it provided very high-quality and modern educational solutions at the international level. Many teachers encounter innovative solutions for the first time precisely by participating in seminars and workshops through the Pestalozzi Programme. However, in 2017, the Programme was closed, which caused a decrease in the possibility of participating in professional training, especially in a multicultural and international context. Recognizing the need to create similar programmes, a working group for the digitization of educational materials was established, whose goal was to find practical answers on how to effectively present, promote and make available the materials of the Council of Europe that were created within the framework of a series of educational projects. The goal was also to reach a large number of teachers, provide new trends in distance learning, increase the advantages and reduce the disadvantages of available applications, etc. (Ozorlić Dominić, 2019). Sandholtz and Ringstaff (2020) indicate how professional training can be effective only when the received knowledge is applied in teaching practice. Due to rapid technological progress, as well as the wide availability of digital tools around the world, professional training through information and communication technology began to be organized and developed. According to the above, it can be concluded that a little less than 20 years ago, the need for international cooperation and connection of teachers with the aim of advancement, learning and growth was noticed. The only logical development path for this idea is online forms of professional training for teachers. Furthermore, given the rapid development of technology and the increasing availability of the Internet, online forms of professional training have become a logical step in the development of educational systems around the world. These formats allow teachers to access a variety of resources, tools and experts from around the world without geographical restrictions. Also, online platforms enable personalized approaches to learning, adapted to the individual needs and preferences of each teacher. In addition, online professional development offers flexibility in terms of time and pace of learning, which is critical given the varying commitments and

schedules of teachers. In addition, interactive online technologies enable collaboration and dialogue among teachers around the world, encouraging the exchange of ideas, experiences and best practices. In light of all of the above, online forms of professional training for teachers are a key instrument for improving educational systems and ensuring the continuous professional development of the teaching community in the 21st century.

### **Advantages and disadvantages of online professional development of teachers with regard to their effectiveness**

All teachers have an obligation to continuously learn and develop. Kiss (2020) indicates that the progress of educational workers, including teachers, educators and professional associates, is based on continuous professional development. This implies the development of creativity in the methodical approach to teaching, the application of modern teaching methods and techniques, and the use of current sources of knowledge. It is important to achieve success in educational work and to encourage students to study independently and constantly develop. Also, the emphasis is on the promotion of human rights and care for the environment, and on active cooperation with colleagues and other stakeholders in society in order to improve the quality of life of young people. As in education as a whole, the Covid-19 pandemic has brought numerous changes, and in this context it is visible in the increasing number of available online educations, professional meetings, seminars and other forms of organized learning intended for teachers.

Numerous authors deal with the issue of online professional development (Binmohsen & Abrahams, 2020). Quinn et al. (2019) define online professional development as professional development through web technologies, which includes different experiences, but also involvement. The authors state that effective online professional training should be conscious and that it is necessary to develop both collaborative and individual learning. There are numerous advantages of online learning. Looking at the financial profitability, it can be concluded that online training is quite profitable. Ozorlić Dominić (2019, p. 26) points out: "The initial investment in the design and development of e-learning programmes is high, but once they are created and published, with the exception of the costs of mentoring and periodic revision, they do not require additional costs for maintenance and development and with minor modifications, they can be used for years; ready-made digital educational content can easily be adapted as needed - made more interactive, refreshed and revised, and is therefore potentially much more current than content created in a non-digital format. The offer of e-learning programs can have a very strong promotional effect for educational institutions that aim to build



an image of being international, open, and future." - oriented through a tailored approach and engaging activities, enabling collaboration with remote colleagues.

The increasingly frequent use of technology for the professional development of teachers is proving to be very effective, especially when you take into account the fact that in this way teachers who are in different remote areas can get support from colleagues and the opportunity for professional development or help in any sense, and that is most often realized in the form of two-way communication supported by digital tools and the network, audiovisual media possibilities, and easy access to the necessary devices (mobile phone, tablet, computer...) (Haßler et al., 2020). However, there are prerequisites for this. As stated earlier, in order for teachers to be able to successfully teach and use technology in their teaching, it is important for them to master different tools and to be able to recognize which tools are appropriate for their students. Bai (2019) indicates that the lack of permanent and adequate support for the use of digital tools is the main obstacle to the effective use of technology in the classroom. On the other hand, the more teachers use digital tools, the more they will learn about them and thus develop their digital competences. This is precisely one positive effect of digital professional training. Research that included 82 studies shows that the use of videos is effective in the professional development of teachers (Major & Watson, 2018). Also, the research shows that the success of professional training can depend on whether the presenters, i.e. the lecturers on the videos, are known to the teachers following a certain professional training, but it can also depend on who moderates the discussions - the presenter or the teachers themselves. Video technology is becoming increasingly prevalent in teacher professional development, which is partly due to its ubiquity and ease of use (Beisiegel et al., 2018). Along with videos, animations are often used for professional development through technology. González and Skultety (2018) find that animations can be quite effective and encourage connection with previous knowledge, as well as understanding. Discussions of animations and videos can facilitate teachers as they often show how the teachers or students present, think, and what their prior knowledge is. Teaching analysis and the use of digital tools were also highlighted as important aspects. Teachers who participate in lesson analysis achieve a deeper understanding of their students and develop a student-centred approach through collaboration with colleagues (Cajkler et al., 2014; Vermunt et al., 2019). It has also been suggested that video analysis contributes to teachers' knowledge and beliefs and improves the quality of teaching (Lewis et al., 2009). Positive effects have been observed in applying what has been learned in improving teaching and understanding the reasons why some approaches work (Bakkenes et al., 2010; Vermunt et al., 2019). However, negative effects have also been identified, especially with less experienced

teachers facing the challenges of educational innovation. Group work on content analysis involves setting research questions or hypotheses, followed by planning how to collect and analyse evidence (Chokshi & Fernandez, 2004). Video recording of lessons sometimes facilitates detailed analysis (Dudley, 2014), providing groups of teachers with the opportunity to better understand and reflect on their work (Fernández, 2005). Digital tools, including video, provide various opportunities to support teachers (Soto et al., 2019), and are already being used as an integral part of research teaching, either implicitly due to the common use of digital tools in classrooms, or explicitly to better understand their role in supporting learning (Nami et al., 2016; Pierce et al., 2011).

Wang et al. (2019) describe the professional development of teachers supported by video lessons, independent research of the subject and collaboration with colleagues. The authors conducted their research by creating an online platform for studying teaching for 24 primary school teachers. On the platform, teachers talked about curricula, video lessons, videos of their own teaching etc. The authors concluded that teachers interacted with each other, which ultimately resulted in the improvement of the teaching process, the introduction of new methods in the teaching process etc. Nickerson et al. (2024) for the purposes of their research created a website that enabled teachers to research content, study, video lessons and participate in joint discussions. A larger number of teachers used the website to access content, while a smaller number of teachers participated in discussions. What the authors particularly emphasized as an advantage of this model of professional development is overcoming time and space barriers. Similar conclusions were reached by Soto et al. (2019), and Koutsouris et al. (2017) point out that digital tools in the professional development of teachers are often responsible for connecting teachers with other experts and professional associates. Stokes et al. (2020) indicate that teachers who opt exclusively for professional development supported by digital tools may develop a sense of less social, emotional and instructional support. Nevertheless, Fishman et al. (2013) in their research confirm that there are no significant differences between live professional training and through digital or online tools. While some studies show the benefits of digital tools in facilitating access to resources, mutual interaction and overcoming spatial and temporal barriers, other studies warn of potential drawbacks such as a lack of social and emotional support. Despite these differences, most research finds no significant differences between traditional forms of face-to-face professional development and those supported by digital tools. Therefore, the conclusion suggests that digital tools have become an indispensable part of contemporary teacher professional development strategies. It is critical to understand how to take advantage of digital tools to foster mutual collaboration and access to resources,

while providing the necessary social and emotional support to achieve optimal teacher professional development.

Online professional training should be based on constructivism, that is, on the continuous cooperation of participants (Bognar & Filipov, 2020), in this case teachers. The authors also emphasize the importance of analysing videos of one's own teaching and communicating with critical friends, which is no longer limited to live communication. On the other hand, the authors conclude that online educations that are limited to browsing content need to be replaced by new ways of learning and teaching. In order for teachers to be able to participate in effective professional training, it is necessary that they have acquired certain knowledge and skills, i.e. that they possess digital competences. According to the The European Digital Competence Framework for Citizens (2016), users in schools, teachers/teachers of digital competence can be divided into three areas: general digital knowledge and skills; competencies for the application of digital technology in education; digital competences for school management. The professional training of teachers can, in accordance with modern expectations, be viewed in a broader sense according to three areas that are intertwined with each other: work with information, technology and knowledge, work with people and work for social welfare. Questioning the digital competences of teachers and professional training in a digital environment can improve the quality of education of students, future teachers and teachers who are involved in the education system. The quality of professional training and the advancement of teachers are the foundation of quality educational systems. The key factor in the success of distance learning, as emphasized by Batarelo Kokić (2020), is student independence, and achieving this goal requires a thorough knowledge of student characteristics and a detailed understanding of the concepts of independence and self-direction, especially in primary school age. In conclusion, constructivism encourages active participation of teachers in their own learning through analysis of their own practice and communication with critical friends, which can be facilitated by using online platforms. However, the importance of moving from passive viewing of content to active learning and teaching methods is emphasised. It is crucial to point out that high-quality professional training of teachers not only improves their teaching practice, but also contributes to the quality of students' education. By understanding the characteristics of students and encouraging independence and self-direction, teachers can achieve success in distance learning. Therefore, continuous reflection on digital competences and the integration of constructivist approaches in professional development are key to improving educational practices and achieving success in modern education.

Furthermore, when talking about the advantages and disadvantages of online professional training, research shows that online education can be as useful and effective as traditional education if the online learning environment is well designed (Sezer et al., 2017). It is interesting to note that comparative studies of professional development through online programmes or traditional live professional meetings did not show a clear trend of favouring one of those two ways among educational workers. On the contrary, research has shown that educators recognized advantages in both conditions, and there were no significant differences between them (Ní Bhroin et al., 2020). An important characteristic of online professional development is the possibility of accessing learning anytime and anywhere (Bognar & Filipov, 2020). Key components for successful online professional training include quality infrastructure, competent lecturers, motivation and preparation of participants. Also, the availability of technical support and a sense of security while using technology are important. Online professional training provides participants with a wide range of opportunities, regardless of the distance between the organizer and the participant's location. Different forms of online education, such as virtual classrooms via video conferences, customized online seminars, courses etc. or flexible online courses, allow each student to adapt to their own pace of learning. The most important advantages of online professional development include flexibility in scheduling, access to resources that are difficult to access locally, increased geographic accessibility to isolated participants, adaptability to volume, and the possibility of receiving support in real time (Celizic & Zovko, 2021). Although online professional training is becoming more and more available, it is important to point out that the presence of online material does not automatically guarantee high quality (Bognar & Filipov, 2020). Furthermore, online learning methods cannot completely replace the experience of traditional methods (Celizic & Zovko, 2021). Key challenges in providing quality professional development for pedagogues include cost and availability, therefore the importance of "computerized" professional development is increasingly emphasized. Online professional development should encourage pedagogues to actively participate, collaborate, lead quality discussions and reflect, instead of simply consuming information. Therefore, short-term webinars and seminars that are reduced to passive acceptance of content should be replaced by new, structured forms of professional learning (Bognar & Filipov, 2020). According to the authors Celizic and Zovko (2021), the most acceptable approach to professional development is a combined model, which includes the integration of modern online forms with traditional methods. This integrated approach enables maximum benefit from both types of learning, providing teachers with a wide range of opportunities for learning and improvement (Guilbaud, 2019).

Online professional development for teachers brings a number of advantages, including flexibility in scheduling and access to resources that are difficult to access locally. Also, they enable increased geographical accessibility to isolated students and adjustment of the pace of learning for each student. The possibility of receiving support in real time and various formats of online education further enrich the learning experience. However, the presence of online materials does not automatically guarantee high quality, so it is important to provide structured and interactive forms of professional learning. The key challenges in providing quality online professional development include costs, availability and the need for active participation of participants. Therefore, the importance of a combined model that integrates modern online forms with traditional methods is emphasised. This integrated approach enables maximum benefit from both types of learning, encouraging educators to actively participate, collaborate and reflect. While online professional development offers numerous advantages such as flexibility and adaptability, it is important to point out that they cannot completely replace the experience of traditional methods. Therefore, it is crucial to provide diverse and interactive formats of online education in order to maximize the benefits of digital technology in the professional development of teachers.

## **Conclusion**

In conclusion, it should be noted that online teacher training has become an indispensable part of the modern education system. Through diverse digital platforms and resources, teachers have the opportunity to improve their knowledge and skills, as well as expand their pedagogical practice. The advantages of online training include learning flexibility, geographic availability, access to a variety of resources, and the ability to interact with colleagues around the world. However, facing challenges such as the need for quality infrastructure, ensuring the motivation of trainees and difficulties in providing social support should also be taken into account. Despite these challenges, it is important to recognize the key role of online teacher training in creating an innovative and adaptive educational environment. Through continuous professional development using online resources, teachers become trained to teach effectively and adapt to changes in the education system. Therefore, further research and encouragement of the use of online training is necessary in order to ensure continuous progress in the quality of education. Furthermore, it is important to emphasize that online professional development offers teachers the possibility of personalized learning, adapted to their individual needs and interests. Through interactive lectures and workshops, teachers can acquire new knowledge and skills in a way that best suits their learning style. Also, online

training often allows teachers to follow the latest trends and research in the field of education, which allows them to stay informed about the latest methods and practices. Improving the digital competences of teachers through online training is essential for the successful integration of technology into the teaching process. Through the use of digital tools and platforms, teachers can create an interactive and stimulating learning environment that encourages student engagement and fosters their creativity and innovation. It is important to point out that online professional development is not only useful for teachers, but also has a positive impact on students. Through continuous professional development, teachers become more motivated and qualified to provide high-quality teaching that promotes academic success and personal development of students. In addition, online training provides an opportunity to build professional networks and collaborate with colleagues from around the world. By sharing experiences and best practices, teachers can expand their horizons and be inspired for further work. However, in order for online training to be effective, it is important to provide continuous support and mentoring to teachers during the learning process. Providing opportunities for reflection and feedback is critical to their professional development and growth.

In order to maximize the benefits of online training, it is necessary to invest in the development of quality online training and resources that are adapted to the needs and goals of teachers. Also, it is important to ensure the accessibility of online education to all teachers, regardless of their geographic location or socioeconomic status. Ultimately, online professional development is a key resource for continuous teacher development and improving the quality of education. Through their application, teachers become better equipped to face the challenges of modern education and support students in their academic and personal progress. Therefore, it is important to continue to encourage and support the use of online training as a means of professional development for teachers in the 21st century.

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## **Teaching English in Multigrade Classrooms in Tuzla Canton**

Nihada Delibegović Džanić and Mirza Džanić

University of Tuzla

### **Abstract**

The paper analyses a scope of challenges that English language teachers face in multigrade classrooms. Teaching in multigrade classrooms is a phenomenon where one teacher instructs students of different ages, grades, and abilities within the same group. Despite the long history and high prevalence of multigrade classes, research on this topic has been largely neglected. There are five main difficulties that teachers might face: how to use and distribute class time, how to design class preparation effectively, how to maintain discipline, how to organize students' independent work, and how to form clear and universal goals for successful work in a combined class. The aim of this paper is to determine the most common difficulties, as well as strategies that can be applied to overcome these challenges.

*Keywords:* teaching English, multigrade classrooms, challenges

### **Introduction**

Multigrade classrooms have an extensive history and are present in almost all parts of the world. These classrooms encompass students of various ages, grades, interests, and abilities within a single instructional group (Little, 1995, p. 1). According to Veenman (1995, p. 320), multigrade teaching is predominantly observed in rural schools, where economic constraints lead to a scarcity of teachers or students to form single-grade classrooms. Despite the longstanding existence of multigrade classrooms, research on this subject has been significantly overlooked. Mulcahy (1992, p. 1) vividly expresses their opinion by saying "They just don't want to admit that we are out there. They think we are like the dinosaurs – extinct!" There is a lack of research on multigrade teaching, making it difficult to make generalizations about the subjects that are best suited for this teaching method. This research particularly focuses on the prevalent challenges faced by multigrade teachers in their teaching practice.

## **Literature review of teaching English in multigrade classroom**

Having one teacher in a classroom where students share the same grade, age, and possess relatively similar abilities and interests is a common occurrence and characterizes a typical single-grade class. However, when the classroom accommodates learners of varying grades, ages, abilities, and interests, it becomes a multigrade classroom, diverging from the norm of a conventional single-grade setting. According to Mathot (2001, p. 18), multigrade classes are present worldwide and involve a single class with two or more groups, each operating at distinct competence or grade levels. Little (1995, p. 1) defines multigrade teaching as the instruction of students of diverse ages, grades, and abilities within the same instructional group. Little (2001, p. 495) emphasizes the distinction between multigrade and single-grade classrooms, noting that single-grade learners are typically assumed to be more homogeneous in terms of age and ability. Miller (1990, p. 3) views the multigrade classroom as a practical alternative to the traditional single-grade organizational structure. Besides the multigrade classroom, several terms are used to describe classrooms of students of different grades and abilities integrated into the same group. Little (1995, p. 1) mentions terms such as ‘multilevel,’ ‘multiple class,’ ‘composite class,’ ‘vertical group,’ ‘family classes,’ and, in the case of one-teacher schools, ‘unitary schools.’ Another term closely connected, even equated with the term multigrade classroom, is the multiage classroom. The distinction between multigrade and multiage classrooms was made by Veenman (1995). Veenman (1995, p. 319) highlights that multigrade classrooms refer to classrooms where students maintain their current grade but are consolidated into a single classroom with a sole teacher. These classrooms are typically organized for administrative purposes. In contrast, multiage classrooms are deliberately formed for pedagogical or philosophical reasons rather than administrative necessity. The primary distinction between multigrade and multiage classrooms boils down to one word: necessity.

Multigrade classrooms are usually formed in rural and remote areas out of necessity. As Mathot (2001, p. 15) explains, multigrade classrooms do not exist by choice but through force of circumstances. The necessity is mainly rooted in the socio-economic situation of a certain country or area. Mathot (2001, p. 15) provides a categorization of prime reasons for multigrade classrooms: 1) small population; 2) inadequate teaching resources due to a poor economic situation; 3) the inveteracy of cultural practices which would interfere with the attendance of students at school; 4) location of the school, which may be in remote and rural areas; 5) when some students are mentally challenged, and there are no schools for special education.

Multigrade classrooms are formed for educational reasons, and some researchers point out the positive effect of learning in a multigrade environment. For many researchers (Pratt,

1986; Miller, 1990; Veenman, 1995), multiage and multigrade classrooms are socially and psychologically healthy places. Economic reasons are the basic reasons for forming a multigrade classroom. As mentioned before, Mathot (2001, p. 15) states that one of the prime reasons for forming a multigrade classroom is inadequate teaching resources due to a poor economic situation. The economic situation is a factor that affects teaching in a multigrade classroom to a large extent.

We can say that linguistic factors influence learning a foreign language in a multigrade classroom in a way that differs from single-grade classrooms. There is a difference not only between learning a foreign language in a natural environment but also in learning a foreign language in single-grade and multigrade classrooms. Multigrade classrooms are also formed because of geographical reasons. Berry (2000, p. 1) says that multigrade schools are usually associated with small schools in remote and sparsely populated areas. Socio-cultural and historical-political factors also influence multigrade teaching. In Mathot (2001, p. 17), we can see some of those factors, such as poor communication with educational systems and authorities, a negative attitude towards multigrade teaching, lack of a government policy on multigrade classrooms leading to a lack of teacher education, inappropriate and irrelevant curriculum and materials, lack of appropriate textbooks, and a lack of support for pedagogic problems.

Previous research on multigrade classrooms focused primarily on the cognitive effects of multigrade teaching. Veenman (1995, p. 390), in his "Cognitive and Non-Cognitive Effects of Multigrade and Multi-Age Classes: A Best-Evidence Synthesis," concludes that there is no difference in learners' achievement between single-grade and multigrade classrooms. Miller (1990, p. 12) also states that there is no difference in academic achievement between single-grade and multigrade classrooms. Pratt (1986, p. 114) sees the positive side of multigrade teaching, further stating that learners have emotional and social benefits from being part of a multigrade classroom, positively affecting their achievement. Mason and Burns (1996, p. 321), on the other hand, suggest that it is more difficult to teach in multigrade classrooms, and accordingly, students' achievements are lower than in single-grade classrooms.

In multigrade teaching, there are benefits and challenges. Mulryan-Kyne (2004, pp. 9-16) presents the most common benefits and challenges of multigrade teaching. Challenges include that a multigrade classroom requires more discipline, there is insufficient time to cover the entire curriculum, teaching resources are limited, and learners' achievements may be poor if teachers are not properly prepared and lack adequate resources. Additionally, teachers often feel isolated. Benefits include more interactive learners and increased opportunities for different

activities, especially group work. The most important advantage of multigrade classrooms is that they provide educational services for rural and remote areas.

Regardless of the advantages and disadvantages of multigrade teaching, Berry (2000, p. 4) suggests techniques for making learning outcomes in multigrade classrooms more successful:

1. **Instructional strategies** – Increase the level of students' independence and promote cooperative group work. This changes the role of the teacher from one who imparts information to one who facilitates. Important strategies include peer instruction (students helping each other), cooperative group work, and self-study.
2. **Planning from the curriculum** – Teachers need to learn how to adapt the curriculum for a multigrade setting.
3. **Instructional materials** – Make instructional materials more suitable for learners' self-study.
4. **School and community** – Involve parents as a resource and extend the curriculum into the community. Teachers should develop connections between the school and the community.

Multigrade teachers often do not receive additional training, and the education system does not offer support for them. Education authorities give little attention to multigrade teachers; however, it is expected that teachers have knowledge of learners' development, the curriculum, and learning strategies. Multigrade teachers need to go one step further compared to single-grade teachers in these obligations, knowledge, and skills. Miller (1990) points out that a multigrade teacher must be well-organized and prepared.

The majority of research on multigrade classrooms has been done to determine teachers' beliefs about multigrade teaching. Veenman and Voeten (1987, p. 14) claimed that teachers find multigrade teaching difficult, especially in terms of lesson planning and individualized materials. Mulcahy (1993, p. 24) states that if teachers have negative beliefs about multigrade classrooms, it is because of the negligence of institutions regarding multigrade classrooms. Mason and Burns (1996, p. 308) point out that better teachers are often assigned to multigrade classrooms, as it is more demanding and challenging to teach in such settings.

Teachers in multigrade classrooms have many functions and roles. Mathot (2001, p. 21) points out the skills and talents of a multigrade teacher: research, supervision, planning, organization, facilitation, management, motivation, and evaluation. Mathot (2001, pp. 22-26) also lists the most important roles of a teacher in a multigrade classroom:

1. **Field Action/Researcher** – In some undeveloped, rural areas, there is no perceived need for students to go to school; at least their parents hold that opinion. The parents of those students are mainly uneducated, and their main goal is to provide basic financial needs for their families. Children in those families are involved in economic activities. The teacher of those students has to research the social situation in that area to improve participation and facilitate learning.
2. **Teacher/Learning Facilitator** – As in every classroom, the teacher in a multigrade classroom has to recognize individual differences among students to facilitate learning and help students develop.
3. **Community Liaison/Resource Person** – Teachers are very important members of society because of their education, position, and responsibility. Due to these facts, they serve as resource persons in the local community.
4. **Social Worker/Counselor** – Teachers serve as social workers to students and their parents. Teachers can also notice some physical disabilities or any other problems that may interfere with students' learning.
5. **Evaluator** – Teachers serve as evaluators when they monitor learners' development and their process of learning.
6. **Material Designer** – Central/provincial authorities of education usually prepare curriculum materials, but teachers still have to develop and prepare their own materials to satisfy the needs of learners of different grades and abilities.
7. **Para-Professional Trainer** – Learning is a process that happens at home and at school, so the teacher has a major role in helping and promoting learning. Teachers can also help in the upbringing of pupils and training their parents.
8. **Government Extension Worker** – Multigrade classrooms are most frequently situated in rural and remote areas, so the school forms a center of such communities. Teachers can help with many government policies, family planning, and health care.
9. **Quality Controller** – Teachers in multigrade classrooms have to help students who do not show progress.
10. **Surrogate Parent** – The atmosphere in multigrade classrooms is calmer and more pleasant than in city schools because learners are not divided by age and grade. In such a classroom, the teacher performs the role of a surrogate parent to students.
11. **Financial Manager** – Teachers of multigrade classrooms very often have the function of a financial manager, especially in situations where financial allotments are made to the school.

**12. Representative of Cultural, Moral, and Political Values** – Teachers of multigrade classrooms should be role models of positive cultural, moral, and political values.

The primary inquiry regarding multigrade teaching revolves around what educators should understand and execute to effectively instruct in a multigrade classroom. Vincent (1999, p. 22) shares insights on this matter. Initially, teachers must possess a comprehensive understanding of child development and be adept at utilizing both heterogeneous and homogeneous grouping methods. Multigrade educators should have a broader range of instructional strategies compared to the majority of single-grade teachers. They should be capable of devising open-ended learning experiences that cater to learners at various levels and skilled in crafting cooperative group tasks. Lastly, proficiency in assessing, evaluating, and documenting learner progress is imperative for multigrade teachers. The community, school administrators, and principals play a crucial role in fostering a supportive school culture and should grasp the fundamental principles of multigrade organization. Establishing such a supportive culture creates an environment where teachers can explore and acquire knowledge about effective multigrade teaching methods.

**Method, data collection and data analysis**

This section discusses in detail the process of data collection and data analysis. It also provides a thorough analysis of the participants in this study. After this project obtained Ethics Approval, the data were collected in Tuzla Canton in primary schools that have multigrade classes using an online questionnaire in English specifically developed for this study. The questionnaire comprised “Part A: Background” and “Part B: Evaluation.” Part A included checkbox questions eliciting information about the participants in the study (e.g., age, gender, years of professional experience), while Part B consisted of both Likert scale and open-ended questions. Teachers’ questionnaire submissions were anonymous to ensure a safe environment for the respondents. Responses to the questionnaires were analysed both quantitatively and qualitatively, utilizing suitable techniques to classify and compare the different data sets. Various descriptive statistics were utilized to analyse the quantitative data so that the relationships between the different examined variables could be identified. The qualitative data gathered via open-ended questions were analysed thematically.

The data were collected in December 2023. A total of 25 (7 M, 18 F) English language teachers from Tuzla Canton, who, at the time when the research was conducted, were all working in a combination of third and fourth grades, participated in the study. Most of the



surveyed teachers, i.e., 15 teachers, had less than five years of experience; seven teachers had more than five years of teaching experience, and three teachers had more than ten years of teaching experience. The situation is similar regarding teachers' experience in multigrade classrooms. Namely, 17 teachers had less than five years of experience, and eight teachers had more than five years of experience. There are no teachers with ten or more years of multigrade teaching experience. All the teachers agreed to participate in the study by signing the consent form. None of the teachers had ever received additional training on teaching in multigrade classrooms.

## **Results and discussion**

There are differences in learners' abilities in single-grade classrooms. Differences among children in multigrade classrooms are even more pronounced because learners in multigrade classrooms are of different ages. Little (1995, p. 12) emphasizes that the expertise needed for effective multigrade classroom instruction seems to be absent from curriculum and teaching methods textbooks, syllabi, teacher's guides, and the content and pedagogy taught in teacher training institutions. Those responsible for training and supporting teachers appear to overlook the essential knowledge necessary for successful multigrade teaching. It is important to identify the most common difficulties faced by multigrade teachers and find strategies to make their tasks easier, thereby making the teaching process more successful. Relying on Veenman's classification of difficulties, we collected data about the most frequent challenges English language teachers in multigrade classrooms encounter.

In this section, we will discuss the responses to the questions in our questionnaire that assess the most frequent difficulties of English language teachers in multigrade classrooms.

*Q1. Which difficulties do English language teachers most frequently encounter in multigrade classrooms?*

This Likert scale consists of a series of seven statements, and respondents were asked to indicate their level of agreement or disagreement with each statement. The response options are presented in a range, from "Never" to "Always," with several intermediate options "Rarely," "Sometimes," and "Often."

*Statement 1: It is difficult to organize the time of the lesson in multigrade classrooms.*

The respondents indicated that it is difficult to organize the time of the lesson in a multigrade classroom. Accordingly, none of the respondents answered that it is never or rarely a difficulty; 6% answered sometimes, 24% answered often, and 70% answered that it is always a problem. In multigrade classrooms, organizing lesson time is challenging due to the diverse

student population. Factors such as varying learning needs, heterogeneous grouping, limited time, and the need for individualized instruction contribute to the complexity. Teachers must balance content delivery that is both challenging and supportive across different grade levels within a limited timeframe. Adjusting to varied learning paces, resource constraints, assessment challenges, and managing transitions between activities further complicate time management. Successfully organizing lesson time in multigrade classrooms necessitates careful planning, flexibility, and a thorough understanding of each student's unique requirements.

*Statement 2: The difficulty I encounter in a multigrade classroom is how to make an adequate lesson plan.*

According to the answers to this question, it is obvious that it is difficult for teachers to make an adequate lesson plan for a multigrade classroom because 62% answered that it is often a problem and 38% answered that it is always a problem. Crafting an effective lesson plan for a multigrade class is challenging. The difficulty arises from addressing the diversity in learning levels, heterogeneous grouping of students, limited time constraints, and the necessity for individualized instruction. Managing varied learning paces, coping with resource constraints, navigating assessment complexities, and ensuring smooth transitions pose additional challenges. Successful lesson planning in multigrade classrooms requires careful consideration, flexibility, and strategic approaches to accommodate the unique characteristics of the learning environment.

*Statement 3: It is difficult to maintain discipline in a multigrade classroom.*

According to answers to this question, discipline in a multigrade classroom is not a concerning problem for teachers of multigrade classrooms because 50% answered that it is rarely a problem, and 35% answered that it is sometimes a problem, 10% answered –often and 5% answered –always. The discipline in the classroom is relative even in the single-grade classroom and it depends on many factors such as the authority of the teacher, teacher's self-esteem, learners, and the surrounding.

*Statement 4: It is difficult to prompt learners to individual work.*

Teachers answered that it is sometimes difficult to prompt learners to individual work (47%); 7% answered that it is never or rarely a problem, 23% answered often, and 23% answered always. Prompting individual work in multigrade classrooms is challenging due to several reasons, including time constraints for managing multiple grades, demanding classroom management, insufficient teacher training, and assessment complexities. Teachers need proper training, access to diverse resources, and effective management strategies to address these challenges and balance individual and group work in multigrade settings.

*Statement 5: I prepare different lesson plans for every group of learners in a multigrade classroom (for example, if I teach the third and fourth grades at once, I prepare one lesson plan for the third grade and one lesson plan for the fourth grade).*

Respondents have to tick the frequency of this statement. We found out that teachers mainly use a quasi-monograde approach to curricula, as suggested by Little and Pridmore (2005), because 73% always use this approach, 21% use it often, and 6% use it sometimes.

*Statement 6: I combine similar curriculum contents to make universal lesson plans (for example, if my yearly plans for the third and fourth grades have similar topics, I adopt only one lesson plan for both grades).*

Teachers sometimes combine similar curriculum contents to make universal lesson plans because 61% sometimes use this approach, 15% use it rarely, 20% never use it, and 4% use it often. The approach suggested by Little and Pridmore (2005) depends on the subject because these results showed us that teaching English in a multigrade classroom can be organized differently than other subjects.

*Statement 7: When I teach vocabulary, grammar, and language skills in a multigrade classroom I use different methods and techniques from those I use in single-grade classrooms.*

Teachers rarely use different methods and techniques than those they use in a single-grade classroom because 45% rarely use different methods and approaches, 33% answered never, 11% answered sometimes, 6% answered often, and 5% answered always.

*Q2: Which qualities are required of multigrade teachers?*

Respondents were asked to decide which quality is the most important and mark it with 5, and the least important with 1. The qualities are enthusiasm, organization, adaptability, multi-tasking, and patience. According to the answers to this question, the most important quality required of a multigrade teacher is organization, followed by enthusiasm, multi-tasking, patience, and lastly, adaptability. We believe enthusiasm is essential for multigrade teachers to effectively navigate the challenges of diverse classrooms, maintain a positive learning atmosphere, inspire students, and adapt to the dynamic nature of teaching multiple grade levels simultaneously.

*Q3: Which language skill is the most difficult to teach in a multigrade classroom?*

Teachers stated that it is most difficult to teach listening (45%), followed by writing (30%), then reading (15%), and speaking, which is considered the easiest (10%). In a multigrade classroom, students may have varying levels of language proficiency, especially in listening skills. Some students may be more advanced, while others may be at a basic level. Tailoring listening activities to meet the diverse needs of students can be challenging. Multigrade

classrooms often face resource constraints, including limited access to audiovisual materials and technology. This limitation can hinder the variety and quality of listening materials that can be used to enhance listening skills.

*Q4: Which is more difficult to teach in a multigrade classroom: grammar or vocabulary?*

Teachers stated that it is more difficult to teach grammar in a multigrade classroom (87%), while 13% stated that it is more difficult to teach vocabulary. Grammar rules are often more complex and abstract compared to vocabulary. Teaching grammatical concepts to students with diverse language proficiency levels, ages, and developmental stages in a multigrade class can be challenging. Tailoring grammar instruction to accommodate various learning styles and levels of language proficiency requires additional effort and planning. Creating interactive sessions that engage all students may be more difficult due to varying interests and comprehension levels.

To reveal the most frequent difficulties that English language teachers in multigrade classrooms encounter, we leaned on Veenman's (1996) categorization of multigrade teaching difficulties. Teachers in multigrade classrooms doubt their abilities to efficiently teach and carry out the ELT material. The findings showed that the teachers' main difficulty in the multigrade classroom is organizing the time of the lesson. This is due to the fact that teachers have to prepare themselves and teach two or more different curricula at the same time. This finding is in line with Mulcahy (1992), who concluded that teachers have to prepare in a way that makes good use of time while trying to equalize their time among all grades and, at the same time, have students working and progressing. Teachers are trained to teach in single-grade classrooms and face difficulties in their efforts to design a curriculum that will effectively teach students in different grades and ages. English language teachers in multigrade classrooms use the same materials they would use in single-grade classrooms. Higgins (2007) also states that multigrade teaching is more demanding than single-grade teaching and leaves little energy for teachers to find more effective strategies in their teaching. As a result, teachers use the same strategies as in single-grade classrooms.

Teachers who participated in the survey hold the opinion that there is no difference in academic achievement between multigrade and single-grade learners and that learners in single-grade and multigrade classrooms are at the same level of knowledge. This finding is in line with Veenman (1995), who points out that there are no differences in achievement between multigrade and single-grade learners. Younger learners in multigrade classrooms learn from older learners, and older learners revise teaching material from lower-grade learners. In a multigrade classroom, younger children see the older children as able to help them, and the

older children see the younger learners as in need of their help. This situation creates a climate of mutual help from which younger and older learners both benefit.

## **Conclusion**

This paper examines multigrade teaching in the context of English language teaching in Tuzla Canton. We explore the difficulties and outcomes of multigrade teaching, as well as teachers' beliefs about multigrade teaching. The most frequent difficulty for multigrade teachers is how to organize the time of the lesson and how to create an adequate lesson plan. The outcome of English language teaching is the same in single-grade and multigrade classrooms. Although the majority of English language teachers do not have additional training about multigrade classrooms and use mono-grade sources, they generally have a positive opinion about multigrade classrooms. Teachers stated that the multigrade environment has a positive effect on learners, especially in the component of speaking skills. To overcome these challenges that teachers face, it is crucial for teachers in multigrade classrooms to receive adequate training, access resources that accommodate diverse learning needs, and employ effective classroom management strategies that balance individual and group work.

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## **Mentimeter's Effect on Cadet Participation and Learning Outcomes in Maritime English**

Olena Diahyleva<sup>1</sup>, Alona Yurzhenko<sup>1</sup> and Olena Kononova<sup>2</sup>

<sup>1</sup>Kherson State Maritime Academy

<sup>2</sup>Maritime Applied College of Kherson State Maritime Academy

### **Abstract**

The paper investigates the effectiveness of Mentimeter, an interactive presentation tool, in enhancing the communicative competence formation of future ship engineers. The research involves a group of cadets from the ship engineering department who participated in a communication skills course, which incorporated Mentimeter as a teaching aid. The research data was collected through surveys and interviews to evaluate the impact of the tool on the cadets' communicative competence development. The findings suggest that Mentimeter positively influenced the cadets' engagement, motivation, and communication skills development. The results of this study could provide valuable insights for educators and trainers in various fields seeking to enhance cadets' communicative competence through innovative teaching approaches.

*Keywords:* maritime education and training, e-learning, MOODLE, digitalization

### **Introduction**

The nature of the modern maritime industry has changed significantly due to technological advancements in the industry. The introduction of automation, digitalization, and other new technologies has improved the efficiency of operations and made it easier to manage vessels and cargo. These technologies have also increased safety and reduced the risk of accidents (Barzii et al., 2020).

Nevertheless, communicative competence remains crucial for seafarers in today's world. Effective communication is essential for seafarers to perform their roles efficiently and safely (Bateson, 2008). They must communicate with various stakeholders, including crew members, port officials, customers, and suppliers, who may speak different languages or come from different cultural backgrounds.

Ship engineers must be able to convey technical information accurately and efficiently, both orally and in writing. They must also be able to listen actively, understand instructions, and give feedback appropriately. Effective communication helps ship engineers avoid misunderstandings, resolve conflicts, and build trust, which can have a significant impact on the success of a shipping operation.

Furthermore, the maritime industry is becoming increasingly digitalized, and ship engineers must be proficient in using digital tools and communicating electronically. Communicative competence can help them effectively collaborate and exchange information with colleagues and stakeholders, regardless of their location. Therefore, communicative competence is critical for ship engineers to operate effectively in a globalized, digitalized, and diverse maritime industry. The research goal is to investigate whether using Mentimeter, an interactive presentation tool, can improve communicative competence among maritime cadets studying English.

### **Analysis of the latest research and publications**

Digitalization has had a significant impact on maritime education and training, both in terms of the content of the training and the methods used to deliver it. Digitalization has made it easier to deliver maritime education and training (MET) online, through e-learning platforms. This has enabled more flexible and accessible training, as students can access the materials and complete the training at their own pace, from anywhere in the world. National scholars have made a significant contribution to the study of this problem. The problem of using digital tools in MET are covered in the works of the following researchers: Nalupa (2022) states that MET has traditionally been the focus of traditional seafarer training in the acquisition and application of practical skills. While this method targets some cognitive capabilities, it is primarily concerned with the training of hands-on practical skills for the completion of specific tasks. Academic education, on the other hand, focuses more on the development of in-depth analytical and critical thinking skills. Ceylan et al. (2022) emphasize the need of transforming the educational and training processes in MET institutions. Emad and Kataria (2022) highlight that education leaders understand the challenges and opportunities for MET perspective; the MET may fall short in producing a maritime workforce with an effective core set of professional skills. Sharma (2022) accentuates that Maritime domain has witnessed steady changes in the way education and training are delivered for preparing its future workforce. Yong and Jeng Yi (2022) expect that the current competencies of seafarers will need new competencies in accordance with the digital age. Erstad, Hopcraft, Vineetha Harish, Tam



et al. (2023) underline that cognitive skills such as reasoning and decision making, problem and conflict solving, and critical thinking are expected to be the most important competencies of seafarers in digital era. They are followed by operational skills, individual skills, and social skills. In our opinion, MET research does not fully cover the communicative competence formation of ship engineers. The results of cadets studying Maritime English to form communicative competence while e-learning are presented in a small number of scientific publications.

### *Problem statement*

Students have a natural curiosity about playing different games. they have an opportunity to be interested due to finding new character-friends, choosing new tools, expanding the territory they own, or receiving awards. All these make teenagers follow their goals while playing.

Lesson digitalization from day to day needs new approaches, in other words, a transition to a new level, like in games. Due to identic boring activities in the lessons, the students stop working actively while carrying out tasks proposed by the teacher. The motivation and interest disappear.

So, we aimed to vary the lessons with new activities, tools, and approaches. Mentimeter as an interactive tool to create presentations, quizzes, word searches, etc. was found.

Another challenge Mentimeter helped with was receiving feedback from students while e-learning. The lack of face-to-face interaction made it difficult to gauge how well the students are understanding the material. We find that feedback is critical in e-learning environments as it helps students to improve, motivates them, supports learning, encourages self-reflection, and builds strong teacher-student relationships.

### *What is Mentimeter?*

Mentimeter is an interactive presentation software that enables presenters to engage with their audience in real time. It allows presenters to create interactive presentations, surveys, quizzes, and polls that can be shared with their audience via a unique code or a link.

Using Mentimeter, presenters can ask questions, and the audience can respond using their smartphones or other devices. The responses are then displayed in real time, allowing the presenter to gauge the audience's opinions and knowledge on a particular topic.

Mentimeter also provides presenters with a wide range of customization options, allowing them to personalize their presentations and tailor them to their audience's needs.

Additionally, the platform offers a variety of presentation templates and pre-made slides, making it easy for presenters to create engaging and interactive presentations quickly.

Mentimeter is widely used not only by educators, but also by business professionals and presenters of all kinds who want to create engaging, interactive, and impactful presentations.

## **Methodology**

This study utilized a quasi-experimental design to examine the effect of Mentimeter on the communicative competence formation of future ship engineers. The sample comprised 45 participants (male, 17-18 y. o.), all of whom study at Maritime Applied College of Kherson State Maritime Academy in Ukraine (ship engineering department). The participants were randomly assigned to either the experimental group, which received e-learning with the use of Mentimeter-based interactive activities (23 cadets), or the control group, which received e-learning (22 cadets).

The communicative competence formation of the participants was evaluated using a pre-test/post-test on LMS Moodle "Maritime English" e-course (30 questions of three difficulty levels). The pre-test was administered to both groups before the training began, while the post-test was administered to both groups after the training was completed. Knuth (1984) mentioned that the communicative competence formation was assessed using a self-assessment questionnaire on LMS Moodle.

The experimental group received e-learning with Multimeter use, which was delivered in the form of interactive lectures, discussions, and group work on LMS Moodle and Zoom. The control group received traditional e-learning on LMS Moodle only.

Data analysis was conducted using both descriptive and inferential statistics. The means and standard deviations of the pre-test and post-test scores were calculated for both groups. The independent-sample test was used to compare the mean scores of the experimental and control groups.

Ethical considerations were taken into account throughout the study. Participants were informed about the purpose of the study, and their participation was voluntary. Informed consent was obtained from all participants, and confidentiality was ensured by using anonymous questionnaires.

Overall, this study aimed to investigate the effect of Mentimeter on future ship engineers' communicative competence formation using a quasi-experimental design. The study design, sample, data collection, and analysis were all carefully planned and executed to ensure the validity and reliability of the findings.

The pre-test was administered to both groups before the training began and the result can be seen in the Figure 1. CG results are the following 2.5 -3.00- 12 cadets; 3-3.25 - 5 cadets; 3.25-3.5 - 4 cadets; 3.5-4.00 - 1 cadet. EG results are 2.5 -3.00- 8 cadets; 3-3.25 - 7 cadets; 3.25-3.5 - 4 cadets; 3.5-4.00 - 2 cadets. and 4.00-4.25 - 2 cadets. As can be seen, EG and CG have no significant difference in the test.

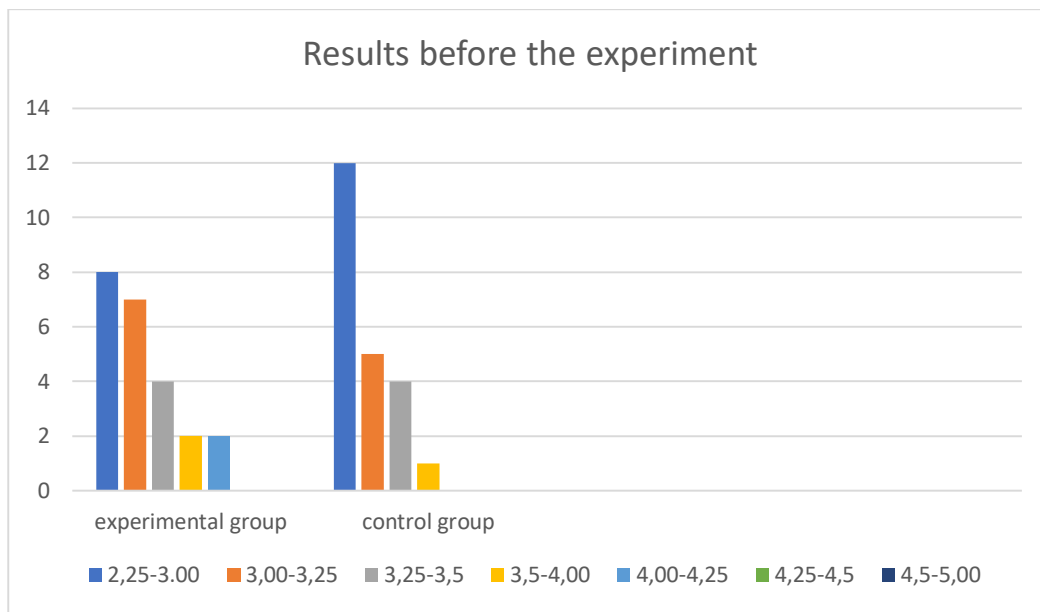


Figure 1. LMS Moodle pre-test on Maritime English results for both EG and CG

## Results

While visiting different workshops participants expect to find new ideas to be used in the future but sometimes instead of interest and curiosity, the meetings can be not interesting, boring, and even ineffective [10]. It can happen because the tutor of a workshop does not interact with participants while speaking or explaining something. The same problem is faced when the teacher is only a lecturer and the students become passive listeners. We find it important to change the situation. Everyone in his/her life reads something, watches TV programmes, studies different subjects so when students are asked to answer the questions, they usually can express their ideas or justify their choice. That is why when we started using Mentimeter as an interactive tool boring lessons became fun, and lectures became a communication at a round table (Maritime English: MODEL course 3.17, 2000).

The tutor in the case of Mentimeter use plays a passive role and helps only to find the correct decision when students are involved in discussions. When the students get to know the voting results some of them become excited, others upset but nobody remains indifferent. The

students become motivated to study and visit online lessons. Also, students can work individually, in pairs or teams.

The Mentimeter website has clear instructions on how to create polls, quizzes, word clouds, surveys, and other interactive activities that can be shared with an audience in real-time (Korach et al., 1984). There are 19 slide types Mentimeter for tutors to create. All types are divided into 4 groups: popular question types; quiz competitions; content slides; and advanced questions. Popular question types are the following: Multiple Choice (Figure 2); Word Cloud; Open Ended; Scales; Ranking; Q and A (Nosov et al., 2020)

To create interactive activity, it is necessary to enter the Mentimeter website, login to your personal Mentimeter account, choose the necessary ready-to-go template (e.g. Student Check-in; Assessment; Reflection; Staff Meeting; Staff Training), and edit it (Korach, Rotem, & Santoro, 1984).

The student Check-in section has some examples of how to use different Mentimeter-based activities during your online lesson (e.g. fun check-in, icebreaker, pre-lecture/midway check-in, course expectation survey etc). There is an example of a pre-lecture activity created with the help of a Mentimeter (Figure 3). Before watching the video on marine engine operations students try to recall the information from the previous lesson on the main engine starting procedure (Ceylan, 2022).

Another Mentimeter's activity is Word Cloud. The tutor can ask his/her students different questions in the easy-to-use editor, gather input from the class, and watch it appear in real-time. It is fully anonymous. Everyone can express his/her ideas and thoughts (Figure 4).

The Mentimeter is very useful for receiving feedback. Feedback is crucial in Maritime English lessons because it helps learners to improve their language skills and achieve their learning objectives. It also allows learners to identify their strengths and weaknesses in their Maritime English skills. Knowing their areas of improvement can help learners focus their efforts on areas that require more attention. Feedback provides learners with an opportunity to correct their mistakes and avoid repeating them in the future. This can help learners to improve their accuracy and fluency in Maritime English.

The tutor can ask the students to answer the questions online. Instead of boring activities students can vote and have fun. Creating different tasks is not difficult due to the range of ready-to-go templates. Their editing goes easily and quickly. Students are able to use apps on their phones (laptops, tablets, PCs etc.) and take part in voting (either via a code, voting link, or by scanning a QR code) (Nalupa, 2022). It is easier for a tutor to assess students' knowledge while they are entertained. Mentimeter can also be used in the post-reading/watching/listening stage.

Such activities help students to consolidate their understanding of the language and improve their communication skills. An example of a Mentimeter-based post-reading activity during the Practice stage of the Maritime English lesson can be seen in Figure 5.

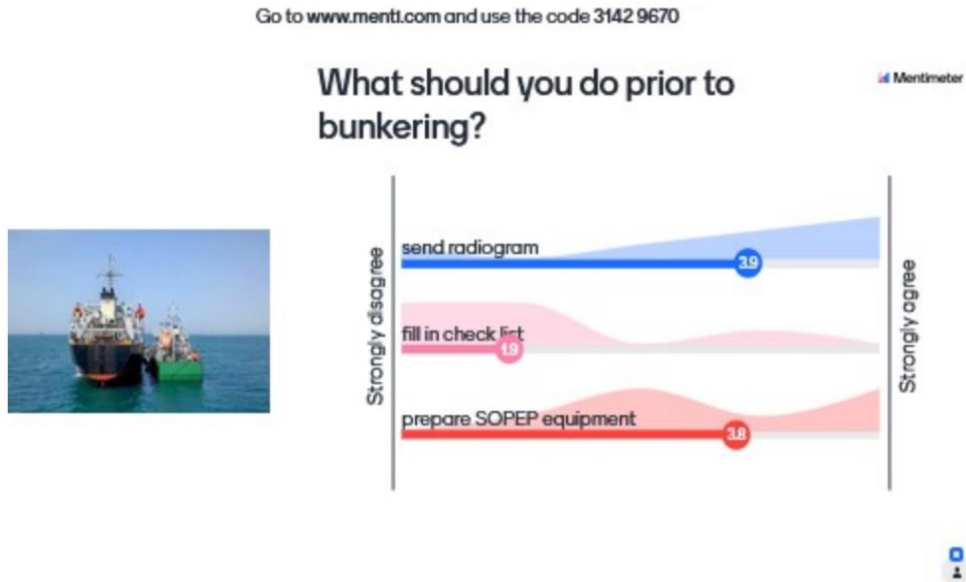


Figure 2. The example of the Multiple Choice tool from the topic "Main Engine Operations" was used as a starter during online class

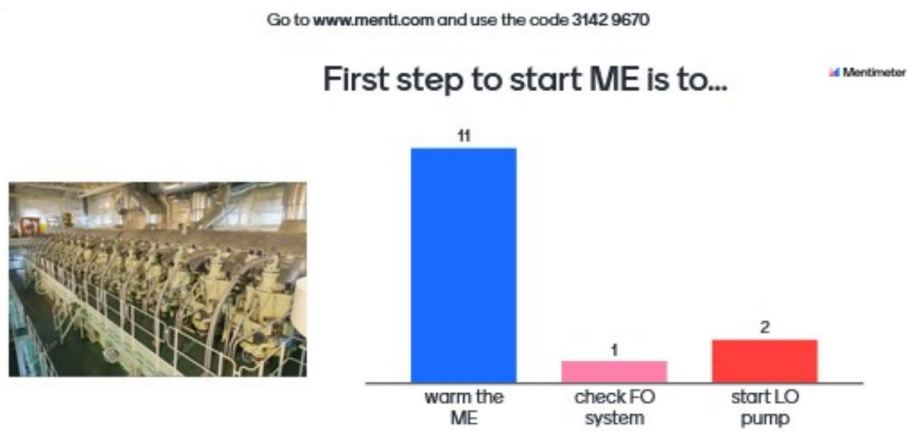


Figure 3. Pre-lecture Mentimeter activity from "Maritime English for future ship engineers" lesson



Figure 4. Word Cloud as a starter at the beginning of the "Maritime English for future ship engineers" lesson

Go to [www.menti.com](http://www.menti.com) and use the code 1743 5775

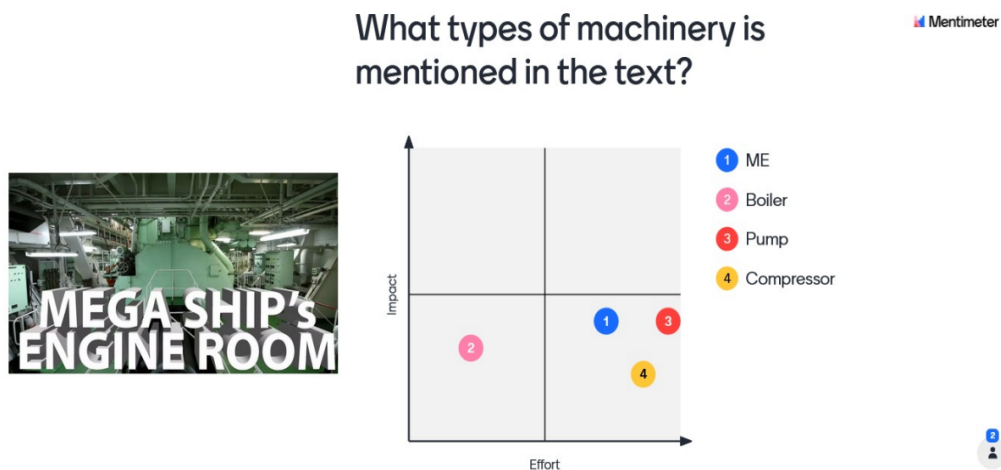


Figure 5. Post-reading activity created with Mentimeter for Maritime English lesson

## Discussion

The results of this study suggest that Mentimeter, an interactive audience response tool, can have a positive effect on the communicative competence formation of future ship engineers. In this discussion, we will examine these findings in detail and consider their implications for maritime education and training (Papadakis et al., 2022).

The results of our study showed that the use of Mentimeter in the classroom was associated with significant improvements in students' communicative competence (EG). Specifically, students who used Mentimeter reported higher levels of confidence in their communication skills, better ability to express their ideas clearly and concisely, and increased

engagement in classroom discussions (R Core Team, 2019). The results of a final test on LMS Moodle can be seen in the Figure 6. CG results are the following 2.5 -3.00- 8 cadets; 3-3.25 - 5 cadets; 3.25-3.5 - 5 cadets; 3.5-4.00 - 4 cadets. EG results are 3.5-4.00 - 2 cadets; 4-4.25 - 5 cadets; 4.25-4.5 - 8 cadets; and 4.5-5.00- 7 cadets. EG has a higher proportion of cadets with higher grades (4.0 and above) compared to CG. The EG also has a wider range of grades, including more cadets with grades in the 4.25-4.75 range. The CG has a higher proportion of cadets with lower grades (below 3.0) compared to the EG. These findings suggest that Mentimeter can be an effective tool for improving the communicative competence of future ship engineers.

One potential explanation for the effectiveness of Mentimeter is that it encourages active participation and engagement from students. By allowing students to respond to questions and provide feedback in real time, Mentimeter creates a more interactive and dynamic classroom environment. This may lead to increased motivation and engagement, which in turn can improve students' communicative competence.

Another potential explanation for the effectiveness of Mentimeter is that it provides immediate feedback to students. By displaying student responses on the screen in real time, Mentimeter allows students to see how their responses compare to those of their peers. This can help students identify areas where they may need to improve and provide an opportunity for the teacher to provide targeted feedback and guidance.

A survey was administered to both EG and CGs through the LMS Moodle platform after the completion of the experiment (Knuth, 1984). The purpose of the survey was to gather feedback from the cadets about their experiences with the course and to assess their perceptions of the effectiveness of the experimental intervention.

The survey consisted of multiple-choice and open-ended questions and was designed to assess various aspects of the cadets' learning experience, including their engagement, motivation, and perceived learning outcomes of the Maritime English course. The survey also asked the cadets to rate their satisfaction with the course overall and with specific aspects of the course, such as the instructional materials, assessments, and instructor support (Semerikov et al., 2020).

The responses to the survey were analysed to compare the perceptions of the experimental and control groups. Overall, EG cadets reported higher levels of engagement, motivation, and perceived learning outcomes compared to CG (Sharma, 2022). The EG also reported higher levels of satisfaction with the course overall and with specific aspects of the

course, such as the instructional materials including Mentimeter-based activities and instructor support.

The open-ended responses from the cadets provided additional insights into their experiences with the course and the experimental intervention. Many cadets in EG noted that the interactive activities and personalized feedback helped them to better understand the course material and apply it to real-world situations onboard the vessel. Some cadets in CG suggested that more opportunities for feedback and interaction would have been helpful (Simakhova et al., 2022).

The survey results suggest that the experimental intervention was effective in improving the cadets' learning experiences and perceived learning outcomes (Voronina, 2017).

Overall, our findings suggest that Mentimeter can be a valuable tool for improving the communicative competence of future ship engineers. By promoting active engagement and providing immediate feedback, Mentimeter can help to develop the communication skills that are critical for success in the maritime industry (Yong, 2022).

The perspectives of our further research is needed to explore the long-term effects of using Mentimeter on the communicative competence of future ship engineers and the extent to which this tool can be applied in other areas of maritime education and training.

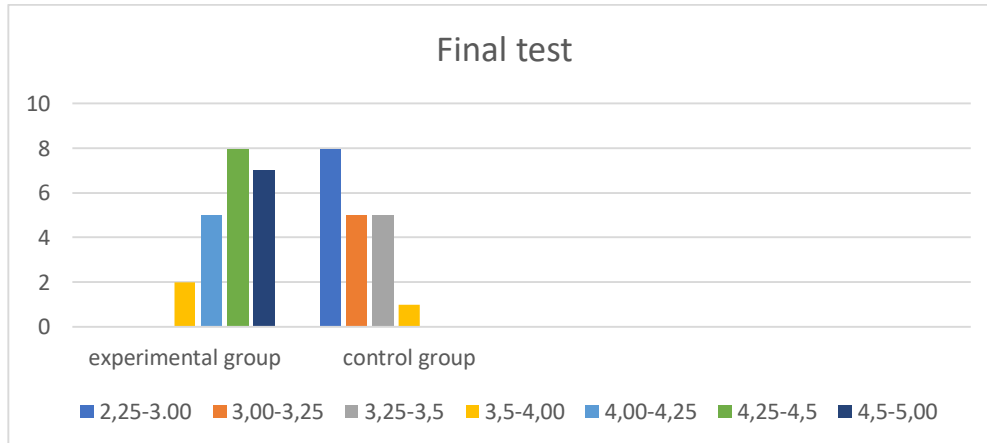


Figure 6. LMS Moodle final testing on Maritime English results for both EG and CG

## Conclusions

The results of this research suggest that using Mentimeter as a tool in maritime education can positively affect the formation of future ship engineers' communicative competence. The use of Mentimeter has been shown to enhance student engagement, encourage active participation, and foster communication and collaboration among students.



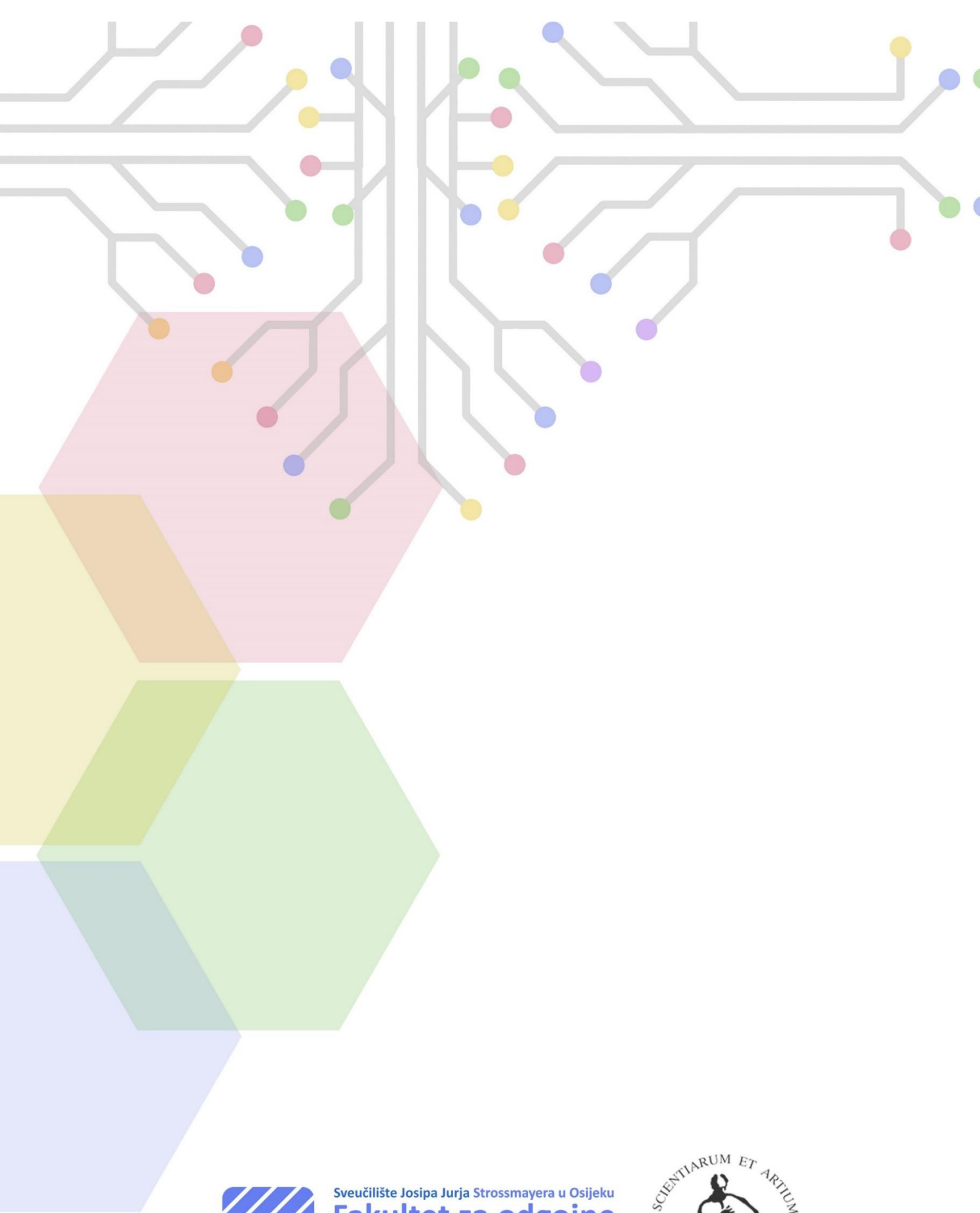
The findings of this study are important because activities created with the help of Mentimeter help keep students engaged and motivated. And when students are engaged, they are more likely to retain information and be successful in their learning.

Therefore, the use of Mentimeter as a tool for developing communicative competence in future ship engineers can be highly beneficial. Further research is needed to explore the long-term effects of using Mentimeter on communicative competence and the extent to which this tool can be applied in other areas of maritime education. However, the results of this study suggest that Mentimeter has the potential to enhance the quality of maritime education and contribute to the formation of competent and effective ship engineers.

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Sveučilište Josipa Jurja Strossmayera u Osijeku  
**Fakultet za odgojne  
i obrazovne znanosti**  
OBRAZUJEMO (ZA) BUDUĆNOST

