PREPARATION OF THE RESEARCH ARTICLE ABOUT INTEGRATED TECHNOLOGIES AND STEAM CONCEPT IN PROJECT PARTNER ORGANIZATIONS AND COUNTRIES.

TYPES OF DIGITAL LEARNING SOLUTIONS MOST USED BY EDUCATORS IN LATVIA

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Abstract

Ongoing educational digitalization, as well as remote learning caused by the COVID-19 pandemic, has significantly promoted the use of digital technologies in education. Consequently, questions regarding the use of different digital solutions (DSs) have arisen, such as which DSs are best suited for teaching and learning, what types of digital learning solutions (DLSs) are freely accessible and what kinds of solutions are still insufficiently available to educators.

The research questions were designed to answer (1) what kind of DSs educators are most interested in and (2) which DSs they have successfully implemented in their practice. To determine the answers to these questions, two separate data sets were combined. The first data set emerged from analysing site traffic data from the educational platform DigiKlase.lv, where DSs and educational resources that can be implemented in the teaching-learning process have been collected. The second data set was gathered during an educational technology mentor professional development course and from the Erasmus+ project "Network of technology INTEGRAtionists in pupils' informal education" (INTEGRA)

educators in Latvia, where 798 educators were surveyed about their success with implementing DSs in their educational practice.

The results demonstrate that educators are most interested in electronic and digital teaching resources that are accessible without registration, are free of charge, and contain methodological recommendations for using them in an educational setting. Educators are also prefer resources that are in the Latvian language. The data reveal that DSs are, overall, less used in preschool settings and in subject areas that are not directly related to the usage of technology. Furthermore, educators report that they have more successfully implemented DSs that emulate the analogue learning process, and fewer choose solutions that are related to working in a digital environment.

Keywords: digital learning solutions, digital solutions, digital teaching materials, educator preferences, post-COVID education

Introduction

Studies show that educators are confused about the appropriate use of digital technologies in teaching (Becta, 2008; Darling-Hammond & Hyler, 2020; Instefjord & Munthe, 2017; McGarr & Gavaldon, 2020; Røkenes & Krumsvik, 2014; Tondeur et al., 2017; Yang & Huang, 2008). There are two widely discussed reasons for the challenges educators experience when implementing digital educational resources. First, the implementation of digital solutions (DSs) in teaching-learning practice is very different from their application in other professions (Krumsvik, 2014). For educators, the employment of DSs does not only mean the use of digital technologies for their personal and work purposes, but also includes the didactics as well as the presentation and explanation of digital technologies to students and the assessment of their usage (Lund & Erikson, 2016). Therefore, educators need in-depth digital skills to be able to provide technology-enhanced learning (Gudmundsdottir & Hatlevik, 2018; Ottestad et al., 2014; Purina-Bieza, 2021). Second, due to rapid technological development, the education sector is not only undergoing active change and facing the need to adapt, but also encountering inevitable resistance and differences in opinions about the solutions implemented in teaching and learning (Macgilchrist et al., 2020; McGarr et al., 2020). Furthermore, the quality, usefulness and availability of different DLSs (digital learning solutions) in education may vary greatly (Daniela et al., 2018; Daniela et al., 2021).

Nevertheless, the COVID-19 pandemic has greatly increased the usage of digital technology in education, as well as highlighting related challenges such as difficulties in communicating learning objectives and the remote teaching-learning process, recognizing false news and searching and selecting information for both students and educators, in addition to

the lack of support when new DSs need to be implemented (Organisation for Economic Co-operation and Development [OECD], 2020; Rubene et al., 2021a). The data for this study were collected during the pandemic period and therefore represent educator practice during both remote and face-to-face teaching-learning processes.

The aim of this study is to explore the DS preferences of Latvian educators, as well as determine the factors driving educators to use specific DSs in their educational practice. These insights may help to design necessary interventions as well as plan the development of DLSs and assess their quality based on educator interests and needs. The research questions are as follows:

1. What kind of DSs are educators most interested in?
2. Which DSs have educators successfully implemented in their practice?

Factors influencing the educator decision when choosing DLSs

Several researchers have addressed the issue of successful DLSs in terms of what factors distinguish proficient educators from failing to implement DSs in education (see Table 1). Many of these researchers base their studies on the technology acceptance model created by Davis (1986), which illustrates user motivation for exploring digital technologies. It consists of interconnected motivational aspects: the perceived usefulness of the DS and ease of use that in combination emerges in the attitude towards usage of the DS and finally results in actual DS application (Davis, 1986). Based on this model, Panigrahi et al. (2018) suggest dividing factors that influence the use of DLSs into two categories: (1) personal factors, including attitude, perceived usefulness, ease of use, enjoyment, etc., and (2) environmental factors, including the characteristics of a solution, as well as aspects of subjective norms and national specificities. Analyses reveal that the most important factor for educators in choosing specific DSs is their attitude, which is closely related to their positive outcome expectations, self-efficacy, previous use of DSs and their colleagues' usage of DSs, as well as their perceived knowledge and skills in using them (Kreijns et al., 2013; Van Acker et al., 2013). Furthermore, the educator's attitude and the usefulness of DSs are essential for the initial adoption of the solution. The experience and satisfaction with the solution lead to continued intentional usage (Panigrahi et al., 2018). Štemberger and Čotar Konrad (2021) note that student and educator attitudes towards digital technologies in education predict their self-reported proficiency in using different types. They argue that there are two types of attitudes that most influence the usage of DSs (Štemberger & Čotar Konrad, 2021):

1. Attitudes towards assessment and critical thinking in education significantly predict self-reported proficiency in using communication, digital and online learning tools.

2. Attitudes towards empowering learners predict self-reported proficiency in using communication tools and digital resources, as well as digital and online learning tools.

Nevertheless, the national culture and practices related to using and implementing DSs play an important role in choosing a DS (Panigrahi et al., 2018), which can be linked to the notion that educators are more engaged in virtual activities when they experience a sense of community in the digital environment (Tsai & Bagozzi, 2014). This has been observed during the COVID-19 pandemic as a social problem in which all educators have been forced to discover new digital possibilities, but are now starting to show greater interest in DLSs and other opportunities to communicate, collaborate, and create a positive learning environment online (Darling-Hammond & Hyler, 2020; Dhawan, 2020; Rubene et al., 2021b).

Table 1

DLS Adoption Factors that Positively Impact Their Usage

	Štemberger & Čotar Konrad, 2021	Faustmann, et al., 2019	Panigrahi et al., 2018	Robles, 2016	Kreijns et al., 2013
PERSONAL FACTORS	1. Attitudes towards assessment and critical thinking 2. Attitudes towards empowering learners	1. User-friendly, easy to use, intuitive 2. Different learning groups and types are considered 3. Encourages interactions between learners	1. Perceived usefulness 2. Perceived ease of use 3. Perceived enjoyment 4. Attitude 5. Perception of interaction 6. Self-distraction/playfulness 7. Cognitive absorption 8. Cognitive age 9. Perceived behaviour control 10. Effort expectancy 11. Performance expectancy	1. Perceived usefulness 2. DLS is appropriate for achieving the objectives 3. Attitude towards using digital technology in education 4. The ease of use 5. Perceived enjoyment of use	1. Attitude 2. Previous use of DLSs 3. Perceived knowledge and skills to use DLS 4. Self-efficacy
ENVIRONMENTAL FACTORS		1. Learning materials are always available 2. Quality of the content 3. Offers variety of activities 4. Free of charge 5. Digital safety	1. Relative advantage 2. Compatibility 3. Trialability 4. Observability 5. Nation's generalized trust 6. Eigenvector centrality and closeness centrality 7. National culture 8. Thermal climate and national wealth 9. Social presence 10. Subjective norm 11. Social influence 12. Facilitating conditions 13. System inhibitors 14. Information inhibitors 15. Technology adoption in organizations		1. Colleagues' use of digital learning materials 2. Subjective norm (influences educators with less experience using ICT)

Classification of DLSs

Although various DLSs are constantly evolving, each solution has its purpose and intended use. As is evident in from previous investigations, educators have different usage patterns for different types of DLSs (García-Martín et al., 2019; Štemberger & Čotar Konrad, 2021). In this study, seven DLSs are distinguished (Rubene et al., 2021a):

1. Electronic teaching resources – non-interactive online teaching materials, such as worksheets, informative presentations, educational videos, and digitized teaching aids, that help to achieve learning objectives and outcomes.

2. Digital teaching resources – interactive online teaching materials, such as online educational games and tests, that also help to achieve learning objectives and outcomes.

3. Learning platforms – digital, interactive online learning and methodological tools that include structured content relevant to the education standards and learning outcomes – theoretical materials complemented with interactive tasks and quizzes providing immediate feedback on learning.

4. Learning management systems – platforms that enable the management and organization of the teaching-learning process in a digital environment and provide the following options: creating virtual classes or groups, exchanging documents, embedding and structuring content, assessing or adding comments (feedback), setting deadlines for tasks and sending specific tasks to a class/group, analysing progress by class or individually, as well as online chat room functionality, etc.

5. Tools for communication and distance teaching and learning – digital tools for remote learning that provide educator-student visual, audial and textual communication, as well as live learning – group work and online chat in addition to video conferencing, video recording, and screen sharing functionalities.

6. Tools for storage/collaboration – tools which allow groups of students and educators to develop a shared documents storage space and collectively work on ideas and projects. These include functionalities such as uploading files, developing shared document maps, editing documents, viewing editing history, leaving comments, etc.

7. Tools for creating learning content – digital tools that can be used to create interactive learning content, such as online tests, quizzes, games and interactive presentations.

Methodology

This study uses methodological triangulation, meaning that the issue was examined using two research methods (Flick, 2007). First, site traffic data were obtained from the educational

platform DigiKlase.lv to determine what kind of DSs educators are most interested in. This nonreactive online data collection shows patterns of user activity that can be enriched using other data-gathering methods, allowing for a more successful interpretation of the findings (Janetzko, 2017). The surveys with educators and prospective educational technology mentors were used to better understand what DSs they have successfully implemented in their practice.

Non-reactive online data collection

DigiKlase.lv is an educational platform developed in Latvia where, at the time of this study, 794 DLSs were assembled and provided for educators, together with methodological recommendations and practical instructions to help implement them in the teaching-learning process. Each learning solution added to the platform has been thoroughly reviewed by the platform creators, determining: the type of the solution based on previously described categories, the languages and learning subjects in which the solution can be used, the terms of use (registration, charge for educators and students, etc.) and many more aspects that educators can view before choosing to use one. The platform continuously saves data about user activity. Therefore, each user is encouraged to become acquainted with and accept the privacy policy terms and conditions. The data used in this study were collected from 5th July 2021 to 22nd December 2021. More than 17,000 unique users from Latvia had visited the platform in this period. In this study, two measurements were analysed: (1) the count of clicks on each DLS description to learn more about it on the DigiKlase platform, and (2) the number of times a DLS was opened, which indicates the frequency at which users accessed the solution (through the webpage link or by opening a document). After the initial click on the solution, it can be opened in several ways: through a direct link to the learning solution, one to the methodological recommendations, or one to the instructions. Each counts as a separate opening of the specific DLS.

The data obtained were coded to depict each DLS, recording the ID, type, language, subject area, pricing, registration, occurrence of the methodological recommendations and instructions for use, as well as number of times a learning solution was clicked on and/or opened. All 794 DLSs were ordered by the amount of times they were clicked or opened. A selection of the most popular DLSs was developed that represented at least 50% of the total DLS (1) clicks, depicted by 104 DLSs, and (2) openings, illustrated by 76 DLSs. The duplications were eliminated, resulting in 111 DLSs (representing 53.5% of user interest) that were further analysed.

An indicator was developed comparing DLS openings with clicks. The indicator depicts each DLS engagement statistic – whether users were willing to further open the DLS after clicking on it. The DLSs were ordered based on engagement indicator from lowest to the highest and divided into two comparative groups: (1) solutions that users were very interested in but were not willing to open, and (2) solutions that users wanted to further explore. Each group contained 55 DLSs, leaving the median solution out of further analysis. Two groups were further analysed to characterize what types of DLSs and resources gain the most user interest.

Survey with prospective technology mentors

A survey was offered to educators who had chosen to take part in a two-year professional development course to become technology mentors (Sarva et al., 2022), as well as Erasmus+ project INTEGRA educators from Latvia who have significant experience in the usage of educational robotics and digital technology for teaching and learning. Educators were informed that the data gathered from their self-evaluation would be anonymized and used in research and had the option of declining to take part in the survey in case they disagreed with sharing their data. The summarized results were accessible to the professional development course material authors and educator trainers to customize the contents for participant needs. The survey questions analysed in this study include work experience, student age group, educator's subject area and the DSs successfully used by educators.

The 1060 responses were collected and compiled in Google Spreadsheets. Duplicate or otherwise invalid answers were removed. The remaining 798 responses were anonymized and further analysed. Google Spreadsheets and SPSS (Statistical Package for the Social Sciences) were used for further data sorting, analysis and visualization.

Results

DLSs that educators are most interested in

In the data analysis, the statistics of the 111 most popular DLSs were used, representing 53% of all DigiKlase.lv DLS clicks and openings. Digital teaching resources were the most common type of DLS (see Table 2). However, there were no communication and distance teaching-learning tools within the most popular DigiKlase.lv DLSs. Another aspect to consider is the engagement for each type of DLS, where electronic teaching resources have the highest opening rate, followed by digital teaching resources and learning management systems.

Table 2

Characteristics of DLSs Included in Analysis

Type of DLS	Number of DLSs	Engagement indicator (DLS opening and click ratio)
Electronic teaching resource (without interactivity)	38	1.02
Digital teaching resource (with interactivity)	43	0.85
Learning platform (with interactive learning content)	8	0.54
Learning management system (with or without content creation functionality)	3	0.84
Tool for communication and distance teaching-learning	0	-
Tool for storage/collaboration	9	0.34
Tool for creating learning content	10	0.35

Dividing the most popular DLSs into (1) ones that are gaining clicks and (2) solutions that are likely to be further explored after a click shows that DigiKlase.lv users are more engaged with electronic and digital teaching resources, which they open and further explore more frequently than any other type of DLS (Fig. 1). These types of DLS users often open a resource more than once, meaning they watch the video instruction about the resource, in addition to becoming acquainted with methodological recommendations, etc.

Figure 1

*User Engagement with Different Categories of DLSs*
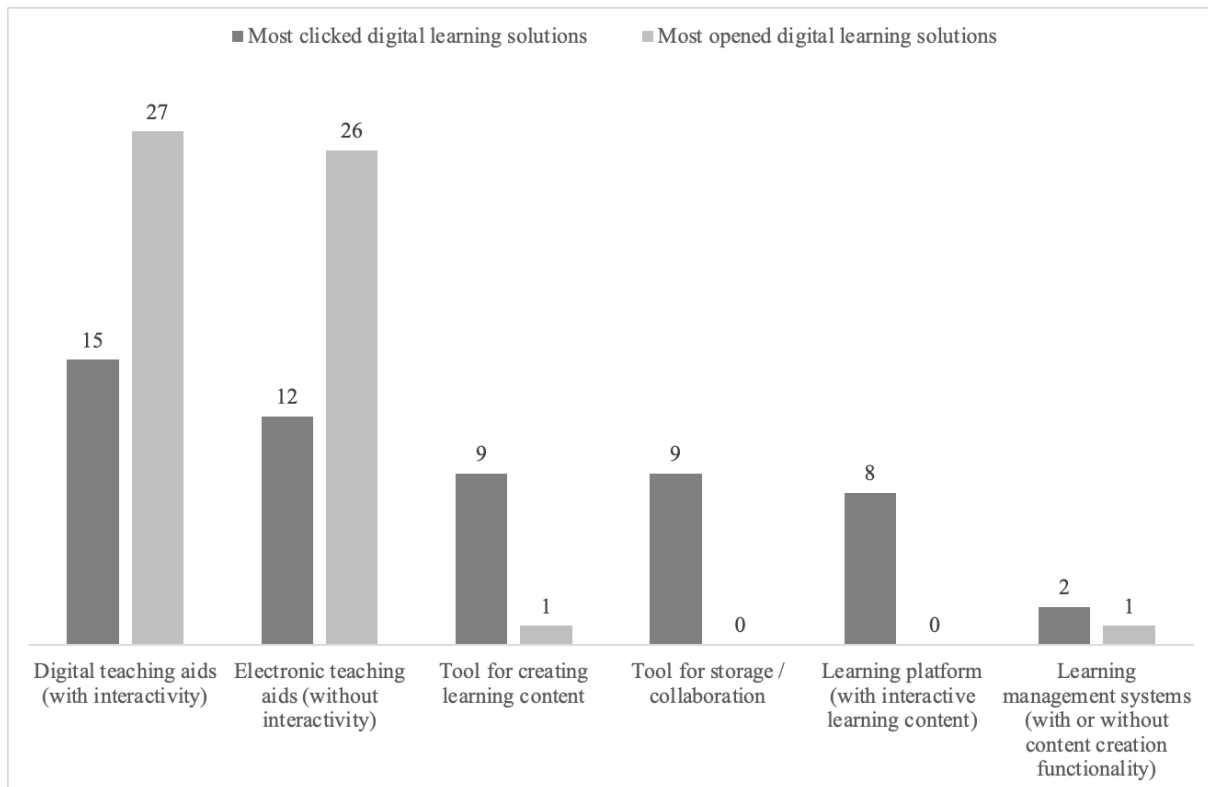
Nevertheless, users show significant interest in digital tools and learning platforms, exploring available information on the DigiKlase.lv platform about their use and functionality, but not opening the tools to examine them further themselves. There are two exceptions where tools are frequently opened after a click: one is a tool for creating learning content and the other is a learning management system (Fig. 1). The tool for creating learning content that was commonly opened was Uzdevumi.lv, which is the largest and most popular assignment development tool in Latvia (Daniela et al., 2018). The most opened learning management system was Skolo.lv, a system recently developed by the national-level project Skola2030 (Skola2030, 2022).

The in-depth analysis of the most popular DLSs reveal the qualities that users are looking for in a DLS (Fig. 2). First, users are looking for and further opening DLSs in Latvian language. DLSs in other frequently used languages in Latvia such as English and Russian are attracting user clicks, but not being further explored. Second, users are interested in DLSs that are free of charge. They are still interested in solutions where part of the functionality is available at no cost, but they usually do not explore them further. Third, registration to use a DLS adversely affects the use of a solution both in the user's first interest in the solution as well as looking into it more. Finally, the support information about a DLS, such as instructions and methodological guidelines, play an important role when the educator is choosing a solution.

Methodological guidelines are present in all 111 most popular DLSs and therefore can be considered an important factor for users choosing to further explore a specific solution. Instructions for use, on the contrary, do not promote the further exploration of the solution, and even have a negative impact on it.

Figure 2

DLS Features and User Engagement
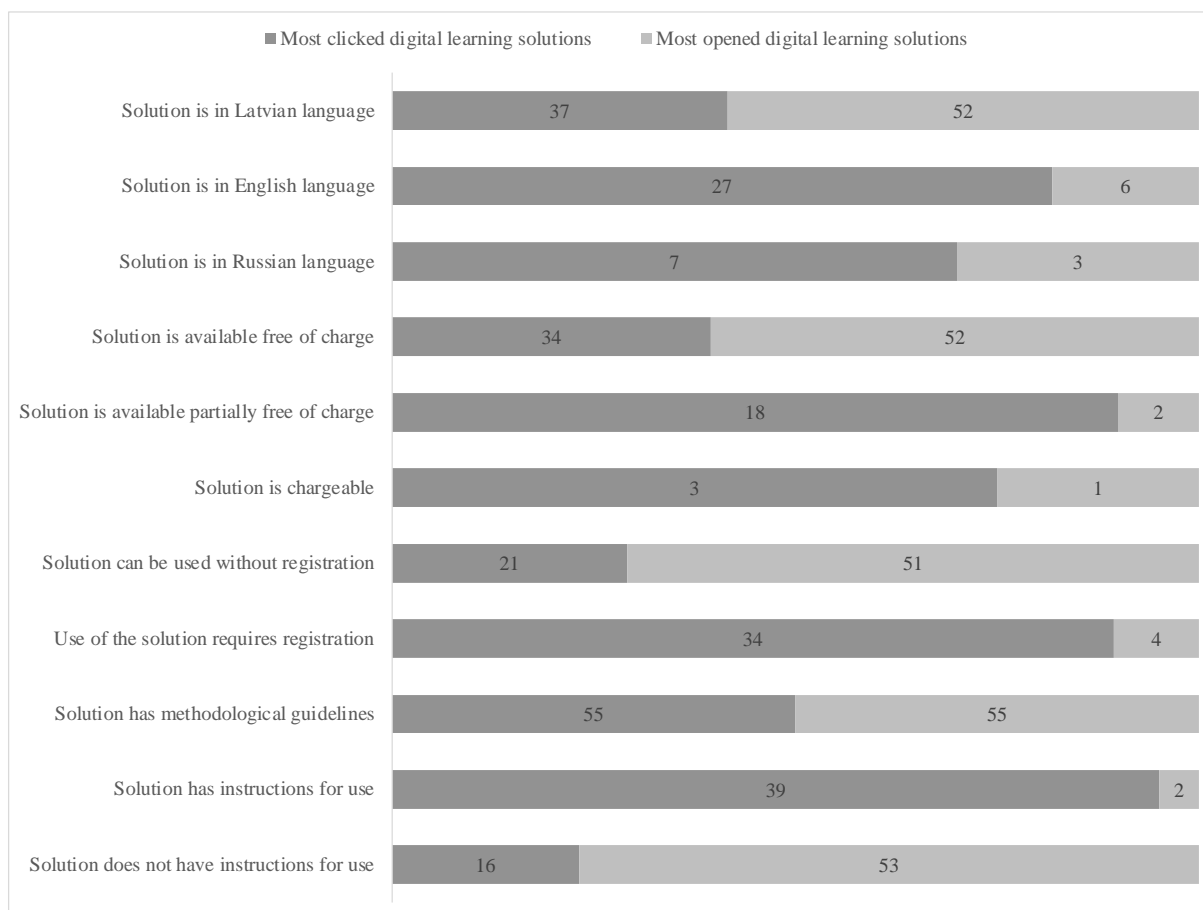
**DSs that educators use in their pedagogical practice**

To determine the use of DSs in pedagogical practice, a survey was carried out amongst educators taking part in a course to become educational technology mentors and educators involved in the Erasmus+ project INTEGRA and 798 responses were analysed. Amongst these, 302 educators were primarily working in preschool, 189 in primary, 161 in secondary and 146 in high school. Of these educators, 66.9% had 10 or more years of experience working in school, and only 4.1% had two or less. Educators from all subject areas took part in the survey, with many of them representing more than one – 57% of the participants associated themselves with the technology area, 37% with mathematics, 37% with languages, 36% with nature sciences,

29% with social sciences and civics, 25% with cultural awareness and self-expression and the least, 16%, with health and physical activities.

The data indicate that learning videos and audio, digital presentations and digital educational books, worksheets and tasks, as well as digital surveys and tests, are the most successful DSs used for educational purposes (Fig. 3). Fewer educators indicate that they have had success with using blogs and homepages, as well as the creation of digital visual materials, in addition to employing co-working documents for educational purposes.

Figure 3

Types of DSs Successfully Used by Educators (Self-Evaluation)
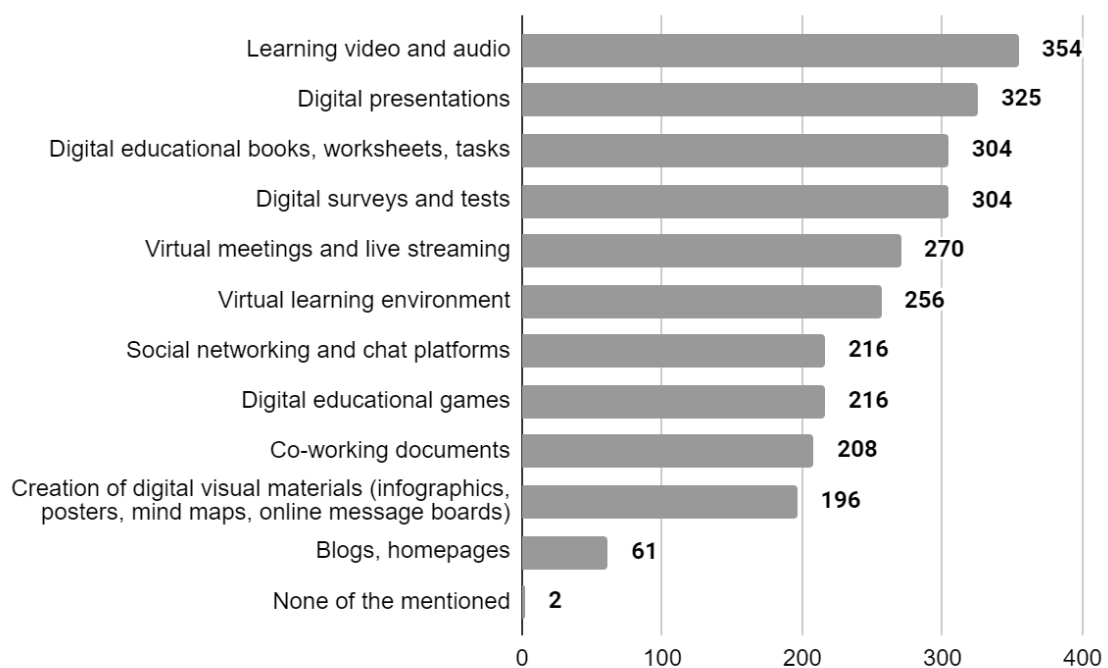
A Kolmogorov–Smirnov test was performed to determine the normality of the data distribution. It was determined that the data are not parametric ($p < 0.01$). Non-parametric statistical methods were therefore used for further data analysis.

A Spearman correlation analysis was run to determine possible correlation between measured factors. No strong correlations were found between the successful use of DSs and educator work experience, student age group or subject area.

Moderate (< 0.7) negative correlation ($p < 0.01$) was noted for the preschool age group, indicating that almost all groups of DSs were less often used successfully for learning within this age group. Moderate positive correlations (> 0.3) that were statistically significant ($p < 0.01$) were observed for the use of online learning environments and digital surveys and tests for elementary school students, and for creating digital visual materials, in addition to using

digital surveys, tests and online learning environments, as well as using digital co-working documents for secondary and high school students. Moderate (> 0.3) and statistically significant ($p < 0.01$) negative correlations were found for using digital surveys and tests in nature science, health and physical activities, languages, social and civics studies and the area of cultural awareness and self-expression. Online learning environments were less successfully employed (correlation < -0.3 and $p < 0.01$) in areas relating to health and physical activities, as well as cultural awareness and self-expression. Digital co-working documents were less successfully utilized in the social and civic study area (correlation < -0.3, $p < 0.01$).

Discussion and conclusions

During the past few years, due to the COVID-19 pandemic, the need for and interest in DLSs have significantly increased. Educators have been forced to discover new ways to interact and organize teaching and learning, consequently developing new skills and exploring the possibilities. In this study, we aimed to answer two questions: (1) what kind of DSs are educators are most interested in, and (2) which DSs have educators successfully implemented in their practice?

The site traffic data from the platform DigiKlase.lv and data from surveys with prospective technology mentors show that educators were most interested in simple electronic or digital teaching resources that closely resembled ordinary workbooks and textbooks. The popularity of these solutions can be explained by educators' previous use of these types of materials (Kreijns et al., 2013), as well as the subjective norm of what kind of solutions can and should be used in the educational setting (Kreijns et al., 2013; Panigrahi et al., 2018; Robles, 2016).

Many electronic and digital teaching resources are available in the national (Latvian) language, are free of charge, and have methodological guidelines. In this study, these factors have demonstrated the increased interest of educators in DLSs and can also be recognized as facilitating conditions for educators choosing DLSs (Panigrahi et al., 2018).

Although the educators showed interest in different types of digital tools that allow active engagement both from educator and student, they were hesitant to further explore them. These DSs are more complex and require learning to use them; therefore, the perceived ease of use and enjoyment can be lower and the effort expectancy to use higher, which repels educators from initially starting to employ them (Panigrahi et al., 2018; Van Acker et al., 2013). The availability of instructions for using a DLS does not convince educators to explore the solution further. On the contrary, the data show that educators avoided DSs with such instructions that

might emphasize the complexity of the solution. Furthermore, many digital tools are not free of charge, which in this study and Faustmann et al.'s (2019) analysis represents a significant obstacle for an educator to start a new DS implementation in the teaching-learning process.

DigiKlase.lv users had a minor interest in tools for communication and distance teaching-learning and learning management systems. This can be explained by technology adoption in organizations (Panigrahi et al., 2018), as, during the pandemic, most schools had agreed-upon tools that they were using for communication with students, parents, and colleagues, meaning educators did not have the need to search for these DSs themselves, but rather adopted the ones already used in their organization.

It can be concluded that educators felt safer using and were more interested in DSs that replicate existing learning experiences than those which are characteristic of the virtual learning environment. Therefore, they preferred replicating existing learning experiences rather than creating new kinds of experiences customized for virtual mediums. In the virtual medium this means stripping much of the possible interactivity offered by DSs, which makes learning more frontal and less engaging. This is concerning, considering how important the engagement of students is, perhaps especially in virtual learning (Abrami et al., 2011; Bernard et al., 2009; Martin & Bolliger, 2018). Educator preferences for less sophisticated DSs have been observed in Latvian education system before (Daniela et al., 2018), and a lack of engaging DLSs, especially in the Latvian language, has also been established (Daniela et al., 2021). To what extent the observed educator preferences were connected with the lack of qualitative DLSs in certain digital formats such as games, as well as the accessibility of DSs and skills for using them properly, in addition to enthusiasm in using more engaging approaches for virtual learning and other influencing factors remains undetermined.

DSs were less used in the preschool age group. This is perhaps not surprising, considering the specifics of the age group, including the fact that many DSs are not well customized for young students for extended periods of time (Gottschalk, 2019; Rubene et al., 2021a). However, even at a young age students should be offered opportunities to learn competence in using DSs, perhaps particularly because this age group is potentially most negatively influenced by the misuse of DSs. DSs are also less used in other subject areas, apart from technologies. This could be connected with the fact that educators teaching subjects connected with technologies are more competent in using DSs, but could also indicate that educators are exposed to social influence and their colleagues' use of DSs and selectively choose DSs based on subjective norms of the subject they teach (Kreijns et al., 2013; Panigrahi et al., 2018).

In terms of further research, it will be important to analyse reasons for educators selecting particular DS for their practice, to understand what support should be provided for educators to better implement DSs in learning and ultimately provide qualitative technology-enhanced learning for every student.

Acknowledgements

References

Abrami, P. C., Bernard, R. M., Bures, E. M., Borokhovski, E., & Tamim, R. M. (2011). Interaction in distance education and online learning: Using evidence and theory to improve practice. *Journal of Computing in Higher Education*, *23*(2–3), 82–103. https://doi.org/10.1007/s12528-011-9043-x

Becta (2008). *Harnessing technology review 2008: The role of technology and its impact on education*.

Bernard, R. M., Abrami, P. C., Borokhovski, E., Wade, C. A., Tamim, R. M., Surkes, M. A., & Bethel, E. C. (2009). A meta-analysis of three types of interaction treatments in distance education. *Review of Educational Research*, *79*(3), 1243–1289. https://doi.org/10.3102/0034654309333844

Daniela, L., Rubene, Z., & Goba, L. (2018). *Datu apkopojums un ārvalstu un Latvijas pieredzes analīze par digitālo mācību līdzekļu pieejamību un izmantošanu vispārējās izglītības mācību satura nodrošināšanai, Izglītības un zinātnes ministrija.* https://www.izm.gov.lv/lv/petijumi-0/datu-apkopojums-un-rvalstu-un-latvijas-pieredzes-analze-par-dml_20181.pdf

Daniela, L., Rūdolfa, A., & Rubene, Z. (2021). Results of the evaluation of learningplatforms and digital learning materials. In L. Daniela & A. Visvizi (Eds.), *Remote learningin times of pandemic: issues, implications and best practice*, 196–210, http://doi.org/10.4324/9781003167594-11

Davis, F. D. (1986). *A technology acceptance model for empirically testing new end-user information systems: Theory and results* [Unpublished doctoral dissertation]. MIT Sloan School of Management.

Dhawan, S. (2020). Online learning: A panacea in the time of COVID-19 crisis. *Journal of Educational Technology Systems*, *49*(1), 5–22. https://doi.org/10.1177/0047239520934018

Faustmann, G., Kirchner, K., Lemke, C., & Monett, D. (2019). Which factors make digital learning platforms successful? In *INTED2019 proceedings* (pp. 6777–6786). IATED. https://doi.org/10.21125/inted.2019.1651

Flick, U. (2007). Concepts of triangulation. In *Managing quality in qualitative research* (pp. 38–54). SAGE Publications. https://doi.org/10.4135/9781849209441

García-Martín, S., Cantón-Mayo, I., García-Martín, S., & Cantón-Mayo, I. (2019). Teachers 3.0: Patterns of use of five digital tools. *Digital Education Review*, 202–215. https://doi.org/10.1344/der.2019.35.202-215

Gottschalk, F. (2019). *Impacts of technology use on children: Exploring literature on the brain, cognition and well-being*. OECD Education Working Papers No. 195. OECD Publishing. https://doi.org/10.1787/8296464e-en

Gudmundsdottir, G. B., & Hatlevik, O. E. (2018). Newly qualified teachers' professional digital competence: Implications for teacher education. *European Journal of Teacher Education*, *41*(2), 214–231. https://doi.org/10.1080/02619768.2017.1416085

Instefjord, E. J., & Munthe, E. (2017). Educating digitally competent teachers: A study of integration of professional digital competence in teacher education. *Teaching and Teacher Education*, *67*, 37–45.

Janetzko, D. (2017). Nonreactive data collection online. In *The SAGE handbook of online research methods* (pp. 76–91). SAGE Publications. https://doi.org/10.4135/9781473957992

Joshi, D., Neupane, U., & Joshi, P. (2021). Synthesis review of digital frameworks and DEPSWALIC digital competency framework for teachers from basic to university level. *Mathematics Teaching-Research Journal*, 13, 108-120.

Kreijns, K., Van Acker, F., Vermeulen, M., & van Buuren, H. (2013). What stimulates teachers to integrate ICT in their pedagogical practices? The use of digital learning materials in education. *Computers in Human Behavior*, *29*(1), 217–225. https://doi.org/10.1016/j.chb.2012.08.008

Krumsvik, R. J. (2014). Teacher educators' digital competence. *Scandinavian Journal of Educational Research*, *58*(3), 269–280. https://doi.org/10.1080/00313831.2012.726273

Lund, A., & Erikson, T. (2016). Teacher education as transformation: some lessons learned from a center for excellence in education. *Acta Didactica Norge*, *10*(2), 53–72.

Martin, F., & Bolliger, D. U. (2018). Engagement matters: Student perceptions on the importance of engagement strategies in the online learning environment. *Online Learning*, *22*(1), 205–222. https://doi.org/10.24059/olj.v22i1.1092

Macgilchrist, F., Allert, H., & Bruch, A. (2020). Students and society in the 2020s. Three future 'histories' of education and technology, *Learning, Media and Technology*, 45:1, 76-89, https://doi.org/10.1080/17439884.2019.1656235

McGarr, O., & Gavaldon, G. (2020). Exploring Spanish pre-service teachers' talk in relation to ICT: Balancing different expectations between the university and practicum school,

Technology,   Pedagogy   and   Education,   27(2),   199–209. https://doi.org/10.1080/1475939X.2018.1429950

McGarr, O., & McDonagh, A. (2019). *Digital competence in teacher education, output 1 of the Erasmus+ funded Developing Student Teachers' Digital Competence (DICTE) project*. DICTE. https://dicte.oslomet.no

Organisation for Economic Co-operation and Development. (2020). *A framework to guide an education response to the COVID-19 pandemic of 2020, OECD Policy Responses to Coronavirus (COVID-19)*. https://doi.org/10.1787/6ae21003-en

Ottestad, G., Kelentrić, M., & Guðmundsdóttir, G. (2014). Professional digital competence in teacher education. *Nordic Journal of Digital Literacy*, *9*, 243–249. https://doi.org/10.18261/ISSN1891-943X-2014-04-02

Panigrahi, R., Srivastava, P. R., & Sharma, D. (2018). Online learning: Adoption, continuance, and learning outcome—A review of literature, *International Journal of Information Management*, *43*, 1–14. https://doi.org/10.1016/j.ijinfomgt.2018.05.005

Purina-Bieza, K. E. (2021). Pedagogical digital competence and its acquisition in a teacher education programme. In *University of Latvia 79th conference: Human, technologies and quality of education*. (pp. 333–351). University of Latvia. https://doi.org/10.22364/htqe.2021.24

Robles, B. (2016). Factores que influyen en el uso y aceptación de objetos de aprendizaje de realidad aumentada en estudios universitarios de Educación Primaria. *EDMETIC*, *6*(1), 203–220. https://doi.org/10.21071/edmetic.v6i1.5815

Røkenes, F. M., & Krumsvik, R. (2014). Development of student teachers' digital competence in teacher education – A literature review. *Nordic Journal of Digital Literacy*, *4*(9), 250–280.

Rubene, Z., Daniela, L., Rūdolfa, A., Sarva, E., & Lubkina, V. (2021a). Lessons learned from pandemics in the context of digital transformation of education. In *University of Latvia 79th conference: Human, technologies and quality of education*. University of Latvia. 521-529. https://doi.org/10.22364/htqe.2021.40

Rubene, Z., Daniela, L., Sarva, E., & Rūdolfa, A. (2021b). Digital transformation of education: envisioning post-covid education in Latvia. In *University of Latvia 79th conference: Human, technologies and quality of education*. University of Latvia. https://doi.org/10.22364/htqe.2021.13

Sarva, E., Purina-Bieza, K. E., & Daniela, L. (2022). Self-evaluation instrument for measuring educators' pedagogical digital competence. In *INTED2022 proceedings* (pp. 3568–3576). IATED. https://doi.org/10.21125/inted.2022.1002

Skola2030. 2022. *Mācīšanās platforma skolo.lv*. https://skola2030.lv/lv/skolotajiem/macisanas-platforma-skololv

Štemberger, T., & Čotar Konrad, S. (2021). Attitudes towards using digital technologies in education as an important factor in developing digital competence: The case of Slovenian student teachers. *International Journal of Emerging Technologies in Learning (iJET)*, *16*(83). https://doi.org/10.3991/ijet.v16i14.22649

Tondeur, J., Aesaert, K., Pynoo, B., Braak, J., Fraeyman, N., & Erstad, O. (2017). Developing a validated instrument to measure preservice teachers' ICT competencies: Meeting the demands of the 21st century. *British Journal of Educational Technology*, *48*(2), 462–472. https://doi.org/10.1111/bjet.12380

Tsai, H.-T., & Bagozzi, R. P. (2014). Contribution behavior in virtual communities: Cognitive, emotional, and social influences. *MIS Quarterly*, *38*(1), 143–164.

Van Acker, F., Buuren, H., Kreijns, K., & Vermeulen, M. (2013). Why teachers use digital learning materials: The role of self-efficacy, subjective norm and attitude. *Education and Information Technologies*, *18*, 495–514. https://doi.org/10.1007/s10639-011-9181-9

Yang, S. C., & Huang, Y.-F. (2008). A study of high school English teachers' behaviour, concerns and beliefs in integrating information technology into English instruction. *Computers in Human Behaviour*, *24*, 1085–1103.