Effects of interaction between teacher and e-Learning system in high school education

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Abstract

The interaction between teachers and e-Learning systems plays a crucial role in the effectiveness and quality of online and blended education in secondary schools. This paper examines how teachers influence the use of e-Learning platforms through their digital competencies, experience in creating educational materials, and perceptions of the usefulness of information and communication technologies, as well as how e-Learning systems shape teaching practices and instructional strategies. The research is based on a quantitative study conducted among secondary school teachers, using a structured survey questionnaire and statistical methods including factor analysis and multiple regression analysis. The findings indicate that teachers' actual and perceived IT knowledge and their experience in developing digital educational materials significantly affect the intensity and scope of e-Learning system usage. The results further highlight the need for systematic professional development of teachers to enhance effective interaction with e-Learning systems. The study provides empirically grounded insights that can support the design of teaching strategies and institutional policies aimed at improving the quality of e-teaching in secondary education.

KEYWORDS: e-Learning, Teachers, Interaction, e-Learning Delivery Systems.

1. Introduction

The rapid development of information and communication technologies (ICT) has significantly accelerated the popularization of new methods for acquiring and transferring knowledge (Khan et al., 2024; Al-Ansi & Fatmawati, 2023; Arzeen et al., 2023; Osman, 2023). In this context, electronic learning (e-Learning) has seen dynamic growth, increased application, and substantial investment (Rabelo et al., 2024; Yas et al., 2024). Currently, education in Bosnia and Herzegovina faces the new challenge of e-education, which aims not to replace traditional pedagogy and teaching methodology entirely, but to expand and transform them, creating a new form of 'face-to-face' learning based on electronic interaction. The aim of this research was to obtain valuable results and solutions that will enhance the educational capacity of secondary schools in fulfilling their core mission. The primary focus areas of this research are e-Learning, learning management systems (LMS), standalone software tools, and virtual classrooms for e-Learning. The teachers who participated in this research utilized the Moodle LMS and the Google Classroom platform in their work. In Bosnia and Herzegovina, these two platforms are the most commonly used for conducting e-Learning. Research shows that teacher quality is the most prominent factor influencing students' perceived

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satisfaction in e-Learning systems (Chugh, 2023). It has been shown that the perception of teaching and learning among new generations of students requires an interactive multimedia approach to teaching content and collaborative learning supported by technology - with which students are very close, and that they will gladly accept such an approach to learning. In this sense, e-Learning systems offer enough opportunities to implement the new role of the teacher. In this context, we propose the main hypothesis: There is an interactivity, which can be expressed qualitatively and quantitatively, between teachers who use modern information and communication technologies (ICT) to support teaching in secondary education and systems for e-Learning. The objectives of the research presented in this paper were derived from the stated hypothesis. To determine whether the intensity and frequency of use of software tools and functionalities of the learning management system in the teaching process is greater, if the teacher has greater real and perceived information technology (IT) knowledge. To determine whether the intensity and frequency of use of software tools and the functionalities of the learning management system in the teaching process can be related to the experience in creating one's own educational digital materials. To examine whether the tendency to use software tools and functionalities of learning management systems in teaching can be explained by previously acquired experience in the use of ICT. To determine whether the scope of the used possibilities of the e-Learning platform is increased by the perception of the efficiency and usefulness of certain resources and software tools, which are used in e-Learning. The following scientific methods were used in the research of the effects of the interaction between the teacher and the e-Learning system: inductive, analysis, survey, comparative and statistical methods. This paper is structured in eight sections as follows. Section 1 is an introduction, and it states the problem addressed by the paper, hypothesis and research objectives. Section 2 – Learning in an electronic environment, explains the specifics and basic principles of learning in an electronic environment. Section 3 describes the creation of educational materials and instructional design. In Section 4, the principles of creating educational materials and the criteria by which they are evaluated are given. In section 5, the specifics of the application of the most commonly used systems for conducting e-Learning in Bosnia and Herzegovina are briefly mentioned, and in section 6, the state of e-Learning in Bosnia and Herzegovina is explained. In section 7, the research methodology is presented, the results of the conducted research are presented and discussed. Within this section, the classification of measurement variables and the evaluation of the measurement scale is given, and the model for proving the hypotheses of the work is presented. This is followed by factor analysis, multiple regression analysis and discussion of the obtained results. Finally, in Section 8, concluding considerations are given with regard to the findings of the research.

2. Learning in an electronic environment

The integration of information and communication technologies into education has enabled new models of teaching and learning supported by virtual classrooms and learning management systems, which facilitate communication, monitoring of learning progress, and timely feedback (Manegre & Sabiri, 2022). However, the effectiveness of learning in electronic environments depends not only on technological infrastructure but also on pedagogical design, teacher engagement, and meaningful interaction throughout the learning process (Sabeh et al., 2021; Tawafak et al., 2020). Prior research also indicates that successful e-teaching requires alignment with learning objectives and active student participation supported by appropriate digital tools (Mastan et al., 2022). In this context, teachers remain central in mediating technology use and shaping interaction quality; recent evidence suggests that pedagogical design and teacher presence are more decisive for effectiveness than infrastructure alone (Arezky, 2025; OECD, 2025).

3. Creation of educational materials and instructional design

The effective use of e-Learning platforms depends on the systematic development of digital educational materials aligned with instructional goals and pedagogical principles. Instructional design provides a framework for organizing content, selecting appropriate digital media, and supporting learning processes within electronic environments. Well-designed digital materials facilitate learner engagement and interaction by structuring content in ways that support understanding and timely feedback (Clark & Mayer, 2023). In e-Learning contexts, teachers assume a dual role as both content providers and designers of learning experiences. Through the creation and adaptation of digital materials, teachers shape instructional strategies and align learning activities with students' needs and curricular objectives. Consequently, experience in developing digital educational materials contributes to more effective use of e-Learning platform functionalities and supports meaningful teacher-student interaction.

4. Principles of creating and evaluating digital educational materials

The quality of digital educational materials depends on the alignment of technological solutions with pedagogical, didactic, and methodological principles. Teachers are responsible not only for selecting appropriate technologies, but also for ensuring that digital materials support learning objectives, student engagement, and meaningful interaction within the e-

Learning environment (Tomić & Juričić, 2018). Given the absence of formally established evaluation criteria for digital educational materials in Bosnia and Herzegovina, this study refers to the criteria proposed by the Croatian Academic and Research Network (CARNet, 2016) as a relevant and structured framework. These criteria encompass scientific accuracy, pedagogical and didactic alignment with curricula, ethical considerations, technological usability, and organizational clarity. An overview of the CARNet evaluation principles is presented in Table 1. The application of such structured evaluation frameworks can support teachers in developing high-quality digital materials and contribute to more consistent and effective e-teaching practices.

Table 1 - CARNet principles for the evaluation of digital educational materials (CARNet, 2016).

Criterion type	Description
Scientific	Accuracy, validity, and relevance of content based on reliable sources
Pedagogical-didactic	Alignment with curriculum, learning outcomes, and teaching methods
Psychological	Adaptation to learners' cognitive abilities and learning styles
Ethical	Promotion of inclusiveness, tolerance, and responsible digital behavior
Technological	Usability, accessibility, interoperability, and responsive design
Organizational	Clear structure, logical organization, and ease of navigation

5. Specifics of applying the most commonly used e-Learning systems in Bosnia and Herzegovina

In secondary schools in Bosnia and Herzegovina, the most commonly used e-Learning platforms are Google Classroom and Moodle. These systems differ in complexity, functionality, and implementation requirements, which directly influences teachers' instructional practices. Google Classroom is often adopted due to its simplicity and low technical demands, whereas Moodle provides a more comprehensive learning management environment with advanced options for course organization, assessment, and monitoring student progress (Ketut Sudarsana et al., 2019; Gamage, 2022). The choice of platform affects the scope and quality of teacher-student interaction and the extent to which digital tools are pedagogically utilized. Teachers' digital competencies, experience, and pedagogical approaches are critical in determining the effective use of platform functionalities. Accordingly, successful implementation of e-Learning systems in secondary education depends not only on technological solutions but also on continuous teacher training and institutional support (Zou et al., 2025).

6. e-Learning in secondary schools in Bosnia and Herzegovina

International assessments indicate persistent challenges in the development of functional competencies among students in Bosnia and Herzegovina. Results from the Programme for International Student Assessment (PISA) show that 15-year-old students achieve scores below the OECD average in reading, mathematics, and science, with a substantial proportion not reaching minimum proficiency levels required for the effective application of knowledge in new contexts (OECD, 2019). The broader educational context, including issues related to evaluation, quality assurance, and learning outcomes, has been analysed in national and international policy reports (UNICEF Bosnia and Herzegovina & OECD, 2022). These findings highlight the need for instructional approaches that promote higher-order thinking and active student engagement. In this regard, e-Learning can support pedagogical transformation in secondary education when it is based on sound pedagogical principles rather than emergency or ad hoc solutions. Research distinguishes between emergency remote teaching and well-designed online learning environments, emphasizing that effective e-Learning requires careful planning, adequate infrastructure, and continuous professional support for teachers (Otto et al., 2024). Accordingly, the development of sustainable e-Learning practices in secondary schools in Bosnia and Herzegovina depends on systematic teacher training, appropriate technological resources, and strategic integration of digital technologies into teaching and learning processes.

7. Research methodology, results and discussion

The primary instrument utilized in this research is a survey questionnaire designed for teachers (Krnjić-sq, 2022), consisting of 25 questions. The majority of the questions in the questionnaire feature "closed" responses, with options provided on a five-point Likert scale. To determine the factors influencing the effects of interaction, direct contact with high school teachers and literature providing primary and secondary data sources were used. The independent variables of the study were determined after combining frameworks and reviewing the literature. The survey questionnaire used in this study was originally developed in the Bosnian language as part of the author's doctoral research and was subsequently translated into English for the purposes of this study. Both the English version of the questionnaire and the classification table of the measured variables are publicly available via the provided online references.

7.1 Classification of measurement variables

The survey was structured such that the questions were grouped into six dimensions aligned with the formulated

questions and research objectives (Krnjić-cmv, 2022). The questions were designed to measure specific manifest variables, including information literacy, use of software tools, skills in creating teaching content, use of e-banking, email correspondence, social networks, and using the Internet for reading news. Additional variables included participation in web conferences, writing and reading blogs, downloading music, playing games, downloading applications, using the Internet for scientific purposes, and preparing e-teaching materials. The survey also addressed the representativeness of resources in e-teaching, experience with software tools for e-teaching, use of the Internet when creating educational materials, downloading media from the Internet, respect for copyright, use of educational materials by other authors, and tools for conducting e-teaching. In addition, the areas of research included teachers' effectiveness in delivering e-Learning on the platform, participation in teacher forums, awareness of increasing digital competencies, the search for innovative solutions, willingness to participate in the development of e-Learning programs, the challenges of preparing for e-teaching, and the evaluation of the platform. Latent variables (dimensions) include a certain group of questions from the survey questionnaire, namely: D1. Actual and perceived IT knowledge of teachers, D2. Frequency and intensity of software tool usage, D3. Experience in producing of own digital educational materials, D4. Extent of utilization of the e-Learning platform's capabilities, D5. Teachers' perception of the usefulness and efficiency of ICT in education, and D6. The need for additional teacher education in the application of modern ICT in e-Learning. Each latent variable was assessed through a specific group of questions in the questionnaire, corresponding to the manifest variables being measured. For each manifest variable, a measurement scale was employed, facilitating the quantitative research. The entire questionnaire with manifest and latent variables represents a scale for measuring the effects of interaction between teachers and the e-Learning system.

7.2 Rating scale

The internal consistency of the measurement scale was evaluated using the Cronbach's alpha coefficient. Prior to assessing the overall scale for measuring interaction effects, the internal consistency of each scale's items (which measured the latent variables) was examined, followed by an evaluation of the internal consistency of the entire scale. Exploratory factor analysis (EFA) using principal component analysis with oblimin rotation was conducted to examine the underlying structure of the measured variables and to generate regression factors for subsequent analyses. The suitability of the data for factor analysis was confirmed using the Kaiser-Meyer-Olkin measure and Bartlett's test of sphericity. Given the focus and scope of this article, detailed tables of factor loadings are not presented; however, the complete factor structure and loading matrices are documented in the author's doctoral dissertation and are available upon request. The research procedure consisted of several sequential phases. Initially, six theoretical dimensions were defined based on the literature review and the conceptual framework of the doctoral research. Subsequently, exploratory factor analysis identified seven empirical factors. One of the extracted factors was not included in further analyses due to its limited theoretical interpretability and relevance to the research model. Therefore, six factors were retained and used as predictors in the regression analysis.

7.3 Research model and hypotheses

A research model was developed based on the relationship between the assessment of the effects of the interaction between teachers and the e-Learning system, and the identified latent variables. This model includes five auxiliary hypotheses derived from the main hypothesis:

AH1: The intensity and frequency of using software tools and the functionalities of the e-Learning system in the teaching process are greater when the teacher possesses higher levels of both actual and perceived IT knowledge.
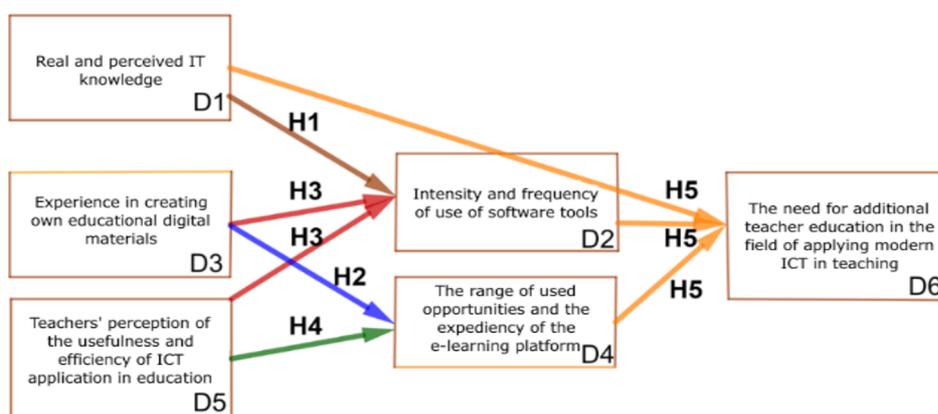

Figure 1 - Flow diagram of the evidence of formulated hypotheses.

AH2: Teachers' inclination to use software tools and the functionalities of e-Learning systems in teaching can be explained by the experience in creating one's own educational digital materials.

AH3: The intensity and frequency of using software tools and the functionalities of the e-Learning system in teaching can be linked to teachers' experience in creating their own digital educational materials, as well as their perceptions of the usefulness of ICT in education.

AH4: The range of used opportunities and the expediency of the e-Learning platform increases with the perception of the efficiency and usefulness of certain resources and software tools, which are used in the performance of e-Learning.

AH5: There is a recognized need to develop a strategy for the professional development of teachers, focusing on the use of modern software tools, educational platforms, and contemporary teaching methods within the e-Learning environment.

Figure 1 shows the flow diagram of the evidence of the formed hypotheses.

7.4 Factor analysis

This technique extracts the maximum shared variance from a set of variables and consolidates it into a single factor. Factor analysis was conducted on all latent variables. In conducting exploratory factor analysis, the principal components analysis method and the direct oblimin rotation method were employed to reduce the variables to a smaller number of factors. These factors represent the fundamental components of the observed latent variables (dimensions). Before conducting the factor analysis on each latent variable, the suitability of the data (Kaiser-Meyer-Olkin index, KMO) and the justification for its use (Bartlett's test of sphericity) were assessed. All tests indicated that the Kaiser-Meyer-Olkin (Tabachnick, Fidell & Ullman, 2007) measure of sample adequacy exceeded the required minimum of 0.6, and that Bartlett's test of sphericity was statistically significant (p=0.000). Therefore, the application of factor analysis is justified, and the data are adequate for this purpose (Tabachnick, Fidell & Ullman 2007). The method of principal components was applied to the scales of the latent variables. During the analysis, one or more factors with an eigenvalue greater than 1.0 (Guttman - Kaiser criterion) were identified. Additionally, the scree plot was examined to confirm the selection of the number of factors, focusing on the 'elbow' points. Based on Cattell's criterion, one or more factors were retained for further analysis of individual latent variables. To interpret the separation of variables into factors, direct oblimin rotation was also applied.

(D1) After conducting an exploratory factor analysis of "real and perceived IT knowledge of teachers," one regression factor was identified, which we named "INFORMATION KNOWLEDGE" and denoted as INF. KNOWLEDGE.

(D2) Similarly, when analyzing the scale "frequency and intensity of use of software tools," one factor was identified, which we named "Frequency of computer use for entertainment, scientific and educational purposes" and marked as FR.ENSCIED.

(D3) The variables of the measuring scale "experience in producing own digital educational materials" were subjected to principal component analysis. Two factors were identified. Regression Factor 1, covering "the use of digital aids and materials", was named UDAM. Regression Factor 2, covering "the use of visual aids and internet materials", was named VISAINTM.

(D4) Exploratory factor analysis of the scale "extent of used platform capabilities" revealed two regression factors. Factor 1, representing "the scope of utilized platform capabilities in e-teaching", was denoted as SUPP1. Factor 2, representing "the scope of used platform possibilities in e-teaching", was denoted as SUPP2.

(D5) The scale "teachers' perception of the usefulness and efficiency of the application of ICT in education" was analyzed, resulting in three factors. Regression Factor 1, associated with motivation and audio/video presentations for students, was named MAUDVID1. Regression Factor 3, related to motivation, interactive presentations, quizzes, and the teacher's usefulness of the platform, was named MIPRQUTEU3. Factor 2 was excluded due to failing the assumption of oblimin rotation and showing poor internal consistency.

(D6) The scale "need for additional teacher education in the domain of modern ICT" underwent principal components analysis. Two factors were identified. Factor 1, representing participation in forums, competence increases, and platform ratings, was named D6.PFICRP1. Factor 2, representing motivation for innovative solutions, development programs, and teaching preparation, was named D6.MISDPTP2.

7.5 Multiple regression analysis and hypothesis testing

The regression factors obtained from exploratory factor analysis were employed in multiple regression to evaluate the formulated model. The constructed model comprises dependent variables and regression factors that were determined through exploratory factor analysis with which the latent variable has a stronger correlation. Each latent variable (D1, D2, D3, D4, D5, and D6) in the model is associated with a corresponding function representing the average values of the respondent's answers to the manifest variables that define it. Each latent variable was operationalized as a composite score calculated as the mean of its corresponding manifest variables. The preliminary analysis evaluated the assumptions necessary for applying standard multiple regression analysis, including sample size, multicollinearity, singularity, presence of outliers, as well as normality, linearity, and homogeneity of variance.

7.5.1 The relationship between teachers' IT knowledge and the intensity and frequency of use of software tools

The standard multiple regression showed that the adjusted coefficient of determination was Adjusted R2 = 0.765 with a standard error of estimation, St.error = 0.4399. The proposed model explains 76.5% of the variance: intensity and frequency of use of e-Learning software tools, as predicted by teachers' real and perceived IT knowledge. The model reached statistical significance: F(1,49) = 164.025, Sig=0.000 at a significance level of p = 0.05. The impact of the independent variable, Real and perceived IT knowledge of the teacher (INF.KNOWLEDGE), on predicting the dependent variable—Intensity and frequency of use of software tools for e-Learning, as measured by the function F(D2)—is significant, with Beta = 0.877. This impact is unique (Part = 0.877) and statistically significant (t = 12.807, p < 0.001) (Table 2).

Based on the established indicators of the strength of the association between the intensity and frequency of software tool use, and the real and perceived IT knowledge of teachers, we can conclude that an increase in teachers' IT knowledge leads to a corresponding increase in the frequency and intensity of software tool use in e-teaching. This conclusion supports the auxiliary hypothesis AH1. Teachers with greater IT knowledge better understand the functionality of software tools and can apply them more effectively in teaching. Such teachers are more inclined to try out new technologies and tools, thereby leading to more creative and interactive approaches to learning. Greater IT knowledge enables teachers to more easily solve potential technical problems and quickly adapt to changes in technology. Knowledgeable teachers can better train students to use individual tools, thus improving the overall e-Learning experience.

7.5.2 The relationship between experience in producing own digital educational materials and the scope of utilized platform features

The standard multiple regression showed that the adjusted coefficient of determination was Adjusted R2=0.704, with the standard error of the estimate being St.error=0.3576. The model explains 70.4% of the variance: the range of utilized platform capabilities. The model reached statistical significance: F(1,49) =119.801, Sig=0.000, with a significance level of p=0.05. The contribution of the independent variable, the use of digital aids and materials (UDAM), to the prediction of the results of the measurement of the dependent variable, the range of used platform capabilities measured by the function F(D4), is Beta=0.842. That contribution is unique (Part=0.842) and statistically significant (t=10.945, Sig.=0.000) (Table 3).

The established indicators of the strength of the connection between the utilized platform capabilities and the experience in producing one's own digital materials indicate that the auxiliary hypothesis AH2 has been confirmed. We can conclude that the tendency for teachers to use software tools and functionalities of learning management systems in class can be attributed to their experience in creating their own educational digital materials. Educators who have already invested in the creation of digital educational materials have

Table 2 - Correlation between intensity and frequency of use of software tools, and teachers' real and perceived IT knowledge.

R=0.877	Adjusted R²=0.765, St.error=0.4399		F(1,49)=164.025	Sig.F, Sig.=0.000[b]		
Model	Unstandardized coefficients		Standardized coefficients	t	Sig. t	Part
	B	Std. Error	**Beta**			
Constant	2.490	.062		40.426	.000	
INF.KNOWLEDGE	.797	.062	0.877	12.807	.000	0.877

Table 3 - Correlation of the range of used platform capabilities with experience in the production of own digital materials and the use of ICT.

R=0.842	Adjusted R²=0.704, St.error=0.3576		F(1,49)= 119.801	Sig.F, Sig.=0.000[b]	
Model	Unstandardized coefficients		Standardized coefficients	t	Sig. t	Part
	B	Std. Error	**Beta**			
Constant	2.297	0.050		45.871	0.000	
UDAM	.554	0.051	0.842	10.945	0.000	0.842

gained an understanding of the various software tools and functionality that an e-Learning systems provides. That experience will enhance their willingness and inclination to use those tools because they know how to apply them in their teaching. Creating your own educational materials involves the use of various digital resources, such as graphics, video content, interactive elements, and other multimedia content. This practice helps teachers to more easily adapt and use the functionalities of e-Learning systems that enable the integration and management of similar content. Teachers who have experience in creating their own digital materials often have an innovative approach to teaching, which can motivate them to use advanced functionalities of e-Learning systems that support innovative teaching and learning methods. There is also the possibility of creating more effective lesson plans. If teachers are used to creating their own educational materials, they have also developed effective strategies for planning and teaching. Such strategies can be supported and enhanced by using the various functionalities of the e-Learning delivery system.

7.5.3 The relationship between the frequency and intensity of the use of software tools with the experience in creating their own educational digital materials and the teachers' perception of the usefulness and efficiency of the use of ICT in education

The standard multiple regression showed that the adjusted coefficient of determination was Adjusted R^2=0.868, with a standard error of the estimate, St.error=0.32551, indicating that the model explains 86.8% of the variance in the frequency and intensity of software tool usage. The model reached statistical significance: $F_{(2,48)}$= 165.208, Sig=0.000, with a significance level of p=0.05. The contribution of the independent variable, the use of digital aids and materials (UDAM), to predicting the frequency and intensity of software tool usage, as measured by the function F(D2), is Beta=0.942. Its unique contribution amounts to (Part=0.714) and is statistically significant (t=13.887, Sig.=0.000) (Table 4). The contribution of the independent variable, motivation, interactive presentations, quizzes, and the teacher's perception of

platform usefulness (MIPRQUTEU3), to predicting the results of the dependent variable, as measured by the function F(D2), is Beta=0.012. Its unique contribution amounts to (Part=0.009) and is not statistically significant (t=0.178, Sig.=0.859) (Table 4).

Based on the results of the standard regression analysis, we can conclude that the most significant contribution to the frequency and intensity of software tool usage comes from teachers' experience in creating their own educational materials. In contrast, the teacher's perception of the usefulness and efficiency of ICT does not make a significant contribution. Based on this, we can partially accept the auxiliary hypothesis AH3. Specifically, the part stating that the intensity and frequency of software tool usage and the functionality of the learning management system in teaching can be statistically significantly related to the experience in creating one's own educational digital materials. However, no statistically significant relationship exists with the teacher's perception of the usefulness of ICT in education. Teachers who create their own materials are more motivated to use e-Learning delivery systems to implement their content and ideas. Such teachers can more easily adapt their teaching to the needs of their students, which increases the frequency of tool usage. Experienced teachers in the creation of materials often explore new tools and functionalities, which increases the intensity of use of e-Learning systems. These factors indicate a strong relationship between experience in creating educational materials and the use of software tools in education. On the other hand, the results of this research showed that the intensity and frequency of software tool usage and the functionality of the learning management system do not have a statistically significant relationship with the teacher's perception of the usefulness of ICT in education. The following reasons may explain this: different motivations: teachers may use tools out of obligation or because of administrative requirements - not because of a personal perception of usefulness; lack of training: if teachers are not adequately trained - they can use tools superficially, without understanding their advantages; technical problems: such as unstable internet connection or bad software, can reduce the perception of usefulness – even

Table 4 - Correlation of the range of used platform capabilities with experience in the production of own digital materials and the use of ICT.

R=0.934	Adjusted R²=0.868 St.error=0.32551		F(2,48)= 165.208	Sig.F, Sig.=0.000ᵇ	
Model	Unstandardized coefficients		Standardized coefficients	t	Sig. t Sig.	Part
	B	Std. Error	**Beta**			
Constant	2.490	.046		53.880	0.000	
UDAM	0.856	.062	0.942	13.887	0.000	0.714
MIPRQUTEU3	0.011	.062	0.012	0.178	0.859	0.009

if teachers use the tools frequently; expectations vs. reality: if teachers expect more from tools than they actually provide - their perception of usefulness may be diminished; contextual factors: specific school conditions, such as infrastructure or peer support can influence perceptions - not just tool use; different definitions of usefulness: the perception of usefulness can differ significantly among teachers - depending on their individual goals and approaches to learning; relationship with students: frequency of use may be high, but if teachers do not see improvements in student engagement or achievement - their perception of usefulness may remain low. These factors indicate the complexity of the relationship between the use of tools and the perception of their usefulness, which makes it difficult to establish a statistically significant relationship. To improve teachers' perceptions of ICT's usefulness in education, the following strategies could be implemented: organize regular trainings and workshops focused on the use of different ICT tools and platforms for conducting e-Learning; share inspiring examples and case studies from colleagues who have successfully integrated ICT into teaching - with a presentation of the results; implement pilot projects in which teachers will be able to test new tools and methodologies; ensure the availability of technical support to help teachers solve problems when using the tools; collect feedback from teachers - about their experiences with ICT and use it for further improvements; help teachers see how ICT can directly support their educational goals and curriculum; implement monitoring and reporting on the results of the application of ICT in teaching - in order to demonstrate the positive impact on learning and student engagement; and create a reward system for teachers who successfully integrate ICT in their teaching.

7.5.4 The relationship between the scope of the used possibilities of the e-Learning platform and the perception of the efficiency and usefulness of individual resources and software tools

The standard multiple regression analysis showed that the adjusted $R^2 = 0.276$, with a standard error of the estimate of 0.5556, indicating that the model explains only 27.6% of the variance in the range of utilized platform capabilities. The model reached statistical significance with $F(1,49) = 20.024$, Sig = 0.000, at a significance level of $p = 0.05$. The contribution of the independent variable: motivation, interactive presentations and quizzes and the teacher's perception of the usefulness of the platform (MIPRQUTEU3), in the prediction of the results of the measurement of the dependent variable, the range of used possibilities of the platform, measured by the function F(D4), is Beta=-0.539. The unique contribution amounts to (Part=-0.539) (t=-4.475, Sig.=0.000) (Table 5).

Based on the results of the standard regression analysis, we can conclude that the scope of the utilized e-teaching platform's capabilities is not adequately explained by the teacher's perception of the efficiency and usefulness of individual resources and software tools, as only 27.6% of the variance can be explained. Furthermore, it has not been established that an increase in teachers' perception of the efficiency and usefulness of certain resources and software tools used in e-teaching also leads to an increase in the range of utilized possibilities of the e-teaching platform. Therefore, the auxiliary hypothesis AH4 should be rejected. Several factors may influence or alter teachers' perceptions of the e-Learning platform's effectiveness and usefulness, thereby affecting the extent of its utilization in the educational process. These factors include: lack of administrative support (insufficient backing from the school administration may lead to a lack of essential resources such as time, training, or financial support for implementing and maintaining the platform), infrastructure and technological resources (inadequate infrastructure, such as a slow internet connection or limited access to computers or tablets, may hinder teachers' ability to fully utilize the e-Learning platform), and resistance to change (some teachers may resist new technologies, which slows down or prevents full integration of the e-Learning.

platform into their work). In addition, each teacher may have different needs in terms of e-teaching based on the subject, the age of the students, or the specific pedagogical methods they prefer, all of which can influence their perception and use of the platform. Enhancing teachers' perception of the efficiency and usefulness of certain resources and software tools in e-teaching can significantly expand the range of possibilities available on the e-teaching platform. In this

Table 5 - Correlation of the scope of used platform capabilities with the perception of efficiency and usefulness of individual resources and software tools.

R=0.539	**Adjusted R²**=0.276, **St.error**=0.5556		**F(1,49)**= 20.024		**Sig.F, Sig.=0.000**[b]	
Model	Unstandardized coefficients		Standardized coefficients	**t**	Sig. t **Sig.**	**Part**
	B	Std. Error	**Beta**			
Constant	2.297	0.078		29.333	0.000	
MIPRQUTEU3	-0.354	0.079	-0.539	-4.475	0.000	-0.539

case, the previously described strategies, including teacher education, support, resources, demonstration of success, motivational programs, evaluation, and continuous support, are also applicable.

7.5.5 The need for additional education of teachers in the domain of modern ICT - as a result of the relationship between real and perceived IT knowledge, the intensity of the use of software tools and the extent of the platform's capabilities

Standard multiple regression shows that the adjusted value of the coefficient of determination, Adjusted R^2 = 0.399, and the standard error of the estimate, St. error = 0.37077, indicate that the model explains 39.9% of the variance in the need for additional education of teachers in the domain of modern ICT, F(D6). The model reached statistical significance: $F(3,47) = 12.087$, Sig = 0.000 at a significance level of p = 0.05. The contribution of the independent variable, the extent of the platform's possibilities used in e-teaching, as evaluated by the regression factor (SUPP2), in predicting the results of the measurement of the dependent variable - the need for additional education of teachers in the field of modern ICT, expressed by the function F(D2) - is Beta = 0.443. The unique contribution is (Part = 0.362) or 36.2%, and it is statistically significant (t = 3.299, Sig. = 0.002) at a significance level of p = 0.05 (Table 6). The contribution of the independent variable—real and perceived IT knowledge of teachers (INF.KNOWLEDGE) - was Beta = 0.176, t = 0.828, Sig. = 0.412, while the contribution of the independent variable—frequency and intensity of use of software tools (FR.ENSCIED) - was Beta = 0.137, t = 0.607, Sig. = 0.546, and neither was statistically significant.

Based on the results of the standard multiple regression and the statistical significance of the independent variables (SUPP2, INF.KNOWLEDGE, and FR.ENSCIED), we obtained the regression equation for assessing the need for additional teacher education in the field of ICT.

Although the need for additional education of teachers in the field of ICT is not sufficiently explained by the range of used platform possibilities (36.2%), the perceived and real IT knowledge of teachers (9%), or the frequency and intensity of use of software tools (6%), we can nevertheless conclude that the model indicates a need for additional teacher education in the application of ICT in e-teaching, thereby validating auxiliary hypothesis AH5. The obtained result is, to a certain extent, a reflection of the lack of adapted training, limited resources, an unfavorable learning environment, lack of continuous and individualized support, and teachers' resistance to change. These obstacles can contribute to the fact that the need for additional education of teachers in the field of ICT is not sufficiently recognized and addressed, despite their perceived and actual IT knowledge and frequency of using software tools. Understanding these barriers is crucial for developing strategies to improve teacher education in ICT and to encourage the successful integration of technology into teaching. With today's technological growth, instructors must learn to utilize various gadgets, such as smartphones and tablet computers, or face marginalization (Haleem, 2022). Adopting a strategy for the professional development of teachers is necessary. Technological progress in the digital sphere is rapid and continuous. New software tools and educational platforms are being developed and improved, and teachers must be trained to use them in order to keep up with these changes. Traditional forms of teaching are often not effective or attractive enough for modern students. E-environments offer a variety of teaching methods that can better suit different learning styles and the needs of students. The use of modern software tools and educational platforms enables greater interactivity and engagement of students in classes. This will result in better learning outcomes and greater motivation to learn. Educational institutions around the world are increasingly recognizing the importance of digital transformation in education. The e-environment

Table 6 - Correlation between the need for additional education of teachers in the domain of modern ICT – F(D6) and the real and perceived IT knowledge of teachers (INF.KNOWLEDGE), the frequency and intensity of the use of software tools (FR.ENSCIED) and the range of used platform capabilities (SUPP2).

R=0.660	**Adjusted R²=0.399 St.error=0.37078**		**F(3,47)= 12.087**	**Sig.F, Sig.=0.000ᵇ**		Tolerance	**VIF**
Model	Unstandardized coefficients		Standardized coefficients	**t**	**Sig. t**	**Part**	
	B	**Std. Error**	**Beta**				
Constant	2.690	0.052		51.804	0.000		
INF.KNOWLEDGE	0.084	0.102	0.176	0.828	0.412	0.091	0.265	3.773
FR.ENSCIED	0.065	0.108	0.137	0.607	0.546	0.067	0.237	4.215
SUPP2	0.212	0.064	0.443	3.299	0.002	0.362	0.667	1.499

enables greater flexibility in the organization of teaching, which can be especially important in situations such as pandemics or other unforeseen events that may affect the regular teaching process. Well-trained teachers in the use of technology have a positive impact on learning outcomes and student motivation. These reasons indicate the need for a systemic approach to introducing professional development strategies for teachers to ensure that educational institutions and teaching processes are prepared for the modern challenges and opportunities provided by technology.

8. Conclusion

The research demonstrated that modernizing the teaching programs alone is insufficient; the didactic and methodological approaches in teaching must also evolve, as student perception demands an interactive and multimedia approach in education. Teachers play a central role in the implementation of information and communication technologies in e-Learning. It has been observed that there is an unsystematic approach to creating educational materials, as well as arbitrary and intuitive use of the functionalities of the e-Learning system by teachers, leading to significant variations in the quality of e-teaching for the same subjects. The new teaching methodology for the online educational process should involve standardized digital educational materials and well-prepared teaching strategies that utilize the various possibilities offered by e-Learning platforms. It is recommended that digital educational materials be developed by instructional designers in collaboration with teachers, using content authoring tools. The study also established that innovative methods recommended in e-teaching include the use of interactive multimedia presentations, educational games, and competitive quizzes, which teachers should implement through software tools. Therefore, teachers need to be proficient in using these tools. Today's students perceive e-teaching as a mode of education where they enjoy teamwork, the connection of teaching content with topics of interest to them, and they expect quick feedback on their progress and immediate responses to their questions. Consequently, these forms of teaching should be integrated into e-Learning by skillfully utilizing the appropriate functionalities of the learning management platform or through separate software tools. However, teachers must be adequately prepared to achieve this goal. The research further revealed that collaboration among teachers on the platform can be beneficial. Significant differences in teachers' digital competencies highlight the need for systematic and continuous improvement of these skills to ensure that their e-teaching is of high quality, motivating, and engaging for students. The acceptance of e-teaching is also closely related to teachers' motivation. The study underscored the necessity of formally recognizing the work and efforts of teachers in online teaching by defining appropriate standards and quality indicators. In this paper an inductive method was employed to prove the main hypothesis, by individually examining the auxiliary hypotheses. After an extensive analysis of the obtained research results, it was concluded that there is interactivity, which can be expressed qualitatively and quantitatively, between teachers who use modern ICT to support teaching in secondary education and e-Learning systems, thereby confirming the main hypothesis of the study.

References

Al-Ansi, A. M., & Fatmawati, I. (2023). Integration of ICT in higher education during Covid-19 pandemic: a case study. International Journal of Learning and Change, 15(4), 430-442.

Arezky, N. F. (2025). E-Learning adoption and its impact on teaching-learning interactions in the digital era. Mauve Journal De Leardu, 2(2), 72–83.

Arzeen, N., Arzeen, S., & Muhammad, H. (2023). The Mediating Role of Self-Directed learning and E-Learning Readiness in Relationship between ICT self-efficacy and Student Engagement. Journal of Development and Social Sciences, 4(2), 286-300.

Chugh, M., Upadhyay, R., & Chugh, N. (2023). An empirical investigation of critical factors affecting acceptance of e-learning platforms: A learner's perspective. SN Computer Science, 4(3), 240. https://doi.org/10.1007/s42979-022-01558-3

Clark, R. C., & Mayer, R. E. (2023). E-learning and the science of instruction: Proven guidelines for consumers and designers of multimedia learning. John Wiley & Sons.

Gamage, S. H., Ayres, J. R., & Behrend, M. B. (2022). A systematic review on trends in using Moodle for teaching and learning. International journal of STEM education, 9(1), 9. https://doi.org/10.1186/s40594-021-00323-x

Haleem, A., Javaid, M., Qadri, M. A., & Suman, R. (2022). Understanding the role of digital technologies in education: A review. Sustainable operations and computers, 3, 275-285. https://doi.org/10.1016/j.susoc.2022.05.004

Joy, J., & Pillai, R. V. G. (2022). Review and classification of content recommenders in E-learning environment. Journal of King Saud University-Computer and Information Sciences, 34(9), 7670-7685.

Hrvatska akademska i istraživačka mreža – CARNet. (2016). Prijedlog kriterija za evaluaciju i preporuka za izradu digitalnih obrazovnih sadržaja. [https://pilot.e-skole.hr/wpcontent/uploads/2016/12/Prijedlog_kriterija_za _DOS.pdf] (Accessed on 20 November 2023.)

Ketut Sudarsana, I., Bagus Made Anggara Putra, I., Nyoman Temon Astawa, I., & Wayan Lali Yogantara, I. (2019). The use of Google classroom in the learning process. In Journal of Physics: Conference Series (Vol. 1175, p. 012165). IOP Publishing.

Khan, W., Sohail, S., Roomi, M. A., Nisar, Q. A., & Rafiq, M. (2024). Opening a new horizon in digitalization for e-learning in Malaysia: Empirical evidence of Covid-19. Education and Information Technologies, 29(8), 9387-9416.

Krnjić.N. (2022). sq – survey questionnaire from: Efekti interakcije nastavnika u srednjoškolskom obrazovanju i elektronskog sistema upravljanja učenjem, doctoral dissertation, University of Vitez, Faculty of Information Technologies, Vitez, 2022. https://drive.google.com/file/d/1bmBd45pqwACvPj_4Ld2dnI5FHt322CzO/view?usp=sharing

Krnjić.N. (2022). sq – classification of measurement variables from: Efekti interakcije nastavnika u srednjoškolskom obrazovanju i elektronskog sistema upravljanja učenjem, doctoral dissertation, University of Vitez, Faculty of Information Technologies, Vitez. https://drive.google.com/file/d/1G7hOrlbQS_VIfvEYy4_9Mv1fUn6fkT-3/view?usp=sharing

Manegre, M., & Sabiri, K. A. (2022). Online language learning using virtual classrooms: An analysis of teacher perceptions. Computer Assisted Language Learning, 35(5-6), 973-988.

Mastan, I. A., Sensuse, D. I., Suryono, R. R., & Kautsarina, K. (2022). Evaluation of distance learning system (e-learning): a systematic literature review. Jurnal Teknoinfo, 16(1), 132-137.

OECD. (2025). The impact of digital technologies on students' learning. OECD Education Working Paper No. 335.

Osman, G. (2023). Formal e-learning in Arab countries: Challenges and opportunities. Learning, Design, and Technology: An International Compendium of Theory, Research, Practice, and Policy, 3179-3203.

Otto, S., Bertel, L. B., Lyngdorf, N. E. R., Markman, A. O., Andersen, T., & Ryberg, T. (2024). Emerging digital practices supporting student-centered learning environments in higher education: A review of literature and lessons learned from the COVID-19 pandemic. Education and Information Technologies, 29(2), 1673-1696. https://doi.org/10.1007/s10639-023-11789-3

Rabelo, A., Rodrigues, M. W., Nobre, C., Isotani, S., & Zárate, L. (2024). Educational data mining and learning analytics: A review of educational management in e-learning. Information Discovery and Delivery, 52(2), 149-163.

Sabeh, H. N., Husin, M. H., Kee, D. M. H., Baharudin, A. S., & Abdullah, R. (2021). A systematic review of the DeLone and McLean model of information systems success in an E-learning context (2010–2020). Ieee Access, 9, 81210-81235.

Tawafak, R. M., Alfarsi, G., AlNuaimi, M. N., Eldow, A., Malik, S. I., & Shakir, M. (2020). Model of Faculty Experience in E-Learning Student Satisfaction. In 2020 International Conference on Computer Science and Software Engineering (CSASE) (pp. 83-87). IEEE.

Tomić V., Juričić D. (2018). Obrazovni trendovi uz potporu digitalnih tehnologija, Zagreb: Hrvatska akademska i istraživačka mreža – CARNet.

UNICEF Bosna i Hercegovina. (2022). OECD-ovi pregledi evaluacije i procjene u obrazovanju: Bosna i Hercegovina, Grafomark d.o.o., Sarajevo.

Yas, N., Dafri, W., Yas, H., & Shwedeh, F. (2024). Effect of e-Learning on Servicing Education in Dubai. In Artificial Intelligence in Education: The Power and Dangers of ChatGPT in the Classroom (pp. 623-639). Cham: Springer Nature Switzerland.

Zou, Y., Kuek, F., Feng, W., & Cheng, X. (2025). Digital learning in the 21st century: Trends, challenges, and innovations in technology integration. Frontiers in Education, 10, 1562391. https://doi.org/10.3389/feduc.2025.1562391