International Journal of Education, Vocational and Social Science
https://e-journal.citakonsultindo.or.id/index.php/IJEVSS
E-ISSN : 2963 4954
IJEVSS

The Influence Of Teachers' Digital Abilities In Developing In-Depth Learning Creativity In High School

Gustina Anugerahwati Soekarno
Magister Administrasi Pendidikan, Universitas Muhammadiyah Surakarta
Sutama
Magister Administrasi Pendidikan, Universitas Muhammadiyah Surakarta

Corresponding Author: g100250004@student.ums.ac.id

Abstract

The transformation of digital education encourages teachers to have adequate digital skills to support the implementation of in-depth learning (mindful, meaningful, joyful learningHowever, teachers' digital skills in learning practices in secondary schools have not been fully accompanied by in-depth and contextual learning creativity. The purpose of this study is to analyze the influence of teachers' digital skills on in-depth learning creativity and to explore teachers' experiences in developing in-depth learning practices.deep learningThe study used an exploratory mixed methods approach with an integrated quantitative and qualitative design. The quantitative phase involved 14 high school teachers at a public high school in Surakarta who were selected purposively. Data were collected through a Likert scale questionnaire and analyzed using simple linear regression. The qualitative phase involved 8 teachers who were interviewed in depth to explore their experiences, strategies, and challenges in implementing immersive learning. Qualitative analysis was conducted through a thematic approach using the interactive model of Saldaña, Miles, and Huberman. The results of the study indicate that teachers' digital skills have a positive and significant influence on immersive learning creativity with an R^2 value of 0.838 and a significance of $p < 0.001$. Qualitative findings indicate that digital skills encourage teachers to produce more reflective, contextual, and enjoyable learning strategies through digital media such as LMS, learning videos, interactive quiz platforms, and material visualization applications. However, teachers still face obstacles such as limited infrastructure, student readiness, and limited time in designing creative learning. This study confirms that teachers' digital skills play a significant role in strengthening immersive learning creativity at the high school level.

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

International Journal of Education, Vocational and Social Science
https://e-journal.citakonsulindo.or.id/index.php/IJEVSS
E-ISSN : 2963 4954
IJEVSS

Keywords:teachers' digital skills, learning creativity, in-depth learning,deep learning, mixed methods

INTRODUCTION

Digital transformation has transformed the way education is designed, implemented, and evaluated in various countries. This change encourages teachers to develop professional skills that are not only oriented toward mastery of material but also the ability to effectively integrate technology into learning. In the context of 21st-century education, teachers' digital skills are a crucial element in creating more adaptive, collaborative, and contextual learning experiences. The OECD emphasizes that modern teacher professionalism requires mastery of digital competencies to adapt learning strategies to students' needs in the digital age (OECD, 2021). Digital skills are no longer understood solely as technical skills, but also encompass pedagogical abilities in selecting, adapting, and integrating technology to support learning objectives.

In the context of Indonesian education, the transformation of learning is further strengthened by the implementation of an in-depth learning approach (*deep learning*) which places more emphasis on the learning process*mindful, meaningful,* And *joyful*The goal is to create more reflective, meaningful, and enjoyable learning so that students can connect learning to real-life contexts, rather than simply understanding the material conceptually. The implementation of immersive learning positions teachers as facilitators tasked with making students' learning experiences more creative and tailored to their characteristics (Waluyo et al., 2025). Therefore, teachers' digital skills are seen as a factor with the potential to strengthen the creativity of immersive learning.

Various studies show that the implementation of in-depth learning still faces a number of challenges. Pahrudin et al. (2025) showed that teacher readiness in implementing*deep learning*influenced by pedagogical mastery and the ability to utilize learning technology. Research by Nurjanah and Suryadi (2025) also found that some teachers still experience difficulties in understanding the practical implementation of the in-depth learning approach. At the same time, developments in educational technology open up opportunities for teachers to be creative in learning by utilizing interactive media, learning videos, and other media.*learning management system*(LMS), as well as digital visualization and evaluation-based applications.

The implementation of teachers' digital skills in educational practice has not always been optimal. Many teachers have used learning technology, but its use is often limited to administrative functions or one-way delivery of material. The use of technologies such as digital

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

presentations, learning videos, and communication platforms is often not integrated to build learning that encourages reflection, problem-solving, and active student engagement. Haditia et al. (2024) explain that the use of digital learning can increase the effectiveness of the learning process when integrated with appropriate pedagogical strategies. However, technology that is not balanced with pedagogical creativity has the potential to produce learning that is procedural and less meaningful for students.

At the high school level, the challenges of implementing immersive learning become more complex. Teachers face high academic demands, heterogeneous student characteristics, and the need to develop learning that is relevant to technological developments. Furthermore, today's students are a digital generation with a more visual, interactive learning style and quick adaptation to technology. This situation requires teachers not only to master the material being taught but also to design creative learning that can increase active student engagement. Mishra and Koehler (2006) through the flow*Technological Pedagogical Content Knowledge*(TPACK) says that effective technology integration requires a balance between mastery of technology, pedagogy, and learning content.

Learning creativity is a crucial component in implementing in-depth learning. Teacher creativity is not only related to the use of engaging media, but also the ability to build learning experiences that foster curiosity, reflection, collaboration, and problem-solving. Amabile (1983) explains that creativity develops through a combination of competence, intrinsic motivation, and innovative thinking skills. In an educational context, teachers with strong professional capacity and digital skills tend to be more adaptable in developing creative learning. Pietsch et al. (2026) found that teachers' professional engagement and pedagogical capacity contribute significantly to the development of teaching creativity.

Initial findings of this study indicate that teachers have utilized various digital platforms in their learning, such as Quizizz, Google Classroom, Canva, YouTube, GeoGebra, and Learning Management Systems (LMS) to support learning activities. However, initial interviews indicated that technology utilization varies among teachers. Some teachers have integrated technology to create reflective and contextual learning, while others still use technology as a traditional presentation tool. Some teachers also cited time constraints, student readiness, and school infrastructure as barriers to developing in-depth learning creativity. These findings suggest that teachers' digital skills do not automatically generate learning creativity, but require a process of pedagogical adaptation and professional experience.

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

Although research on teachers' digital skills and deep learning continues to grow, there are gaps in the research (*research gap*) which needs to be studied further. Most previous studies place the digital capabilities of teachers and*deep learning*as a stand-alone variable or using only a quantitative approach to measure teacher readiness levels (Pahrudin et al., 2025; Nurjanah & Suryadi, 2025). Previous research is still limited in explaining how teachers' digital skills influence contextually in-depth learning creativity in secondary school settings. Furthermore, studies integrating quantitative and qualitative approaches to understand the relationships between variables and teacher experiences are still relatively limited.

Based on this gap, an exploratory mixed methods approach was used in this study by integrating quantitative analysis through simple linear regression on 14 teachers with qualitative exploration through in-depth interviews with 8 teachers. The approach chosen was aimed at gaining a comprehensive understanding of the relationship between teachers' digital skills and deep learning creativity while also understanding teachers' experiences, strategies, and challenges in learning practices. Specifically, this study aims to: (1) analyze the influence of teachers' digital skills on deep learning creativity at the high school level; (2) explore teachers' experiences in developing learning*mindful, meaningful,* And *joyful*digital technology-based learning; and (3) identifying challenges and teacher adaptation strategies in implementing immersive learning. Theoretically, this research is expected to enrich the study of the relationship between teachers' digital skills and immersive learning creativity. Practically, the research results are expected to serve as a basis for schools and policymakers in designing strategies to strengthen teachers' digital competencies and innovate learning at the high school level.

METHOD

This research uses an exploratory mixed methods approach (*exploratory mixed methods*) which integrates quantitative and qualitative approaches to gain a more comprehensive understanding of the relationship between teachers' digital skills and creativity in in-depth learning at the high school level. This approach was chosen because the research aims to test the influence between variables through statistics, as well as to study teachers' experiences, perceptions, strategies, and challenges in developing learning.*mindful, meaningful,* And *joyful learning*. Mixed methods designs enable researchers to obtain stronger findings through the integration of numerical and narrative data, allowing for more contextual and in-depth interpretation of the results (Creswell & Plano Clark, 2018).

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

International Journal of Education, Vocational and Social Science
https://e-journal.citakonsultindo.or.id/index.php/IJEVSS
E-ISSN : 2963 4954
IJEVSS

The research was conducted at a public high school in Surakarta City, Central Java, Indonesia. The research location was chosen purposively because the school had begun implementing digital-based learning transformation and the initial implementation of immersive learning (*deep learning*The research took place from February to May 2026, encompassing instrument development, quantitative data collection, in-depth interviews, data analysis, and verification of findings. This timeframe was chosen to allow researchers to obtain sufficient data on teacher learning practices in a real-world school context.

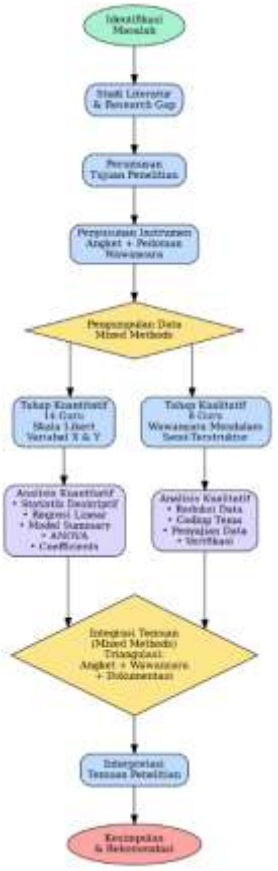


Figure 1. Exploratory Mixed Methods Research Flow

Source: Processed by Researchers (2026)

In the quantitative stage, research participants consisted of 14 teachers from various subjects selected using a purposive sampling technique. Respondent selection was based on several criteria, namely: (1) active teachers in the current academic year, (2) using digital technology in learning, (3) having experience implementing or being familiar with in-depth learning, and (4) being willing to be research respondents. The quantitative stage aims to test the

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

influence of teachers' digital skills (X) on in-depth learning creativity (Y) through simple linear regression.

In the qualitative phase, the study involved eight teachers selected from quantitative respondents based on their varied teaching experience, use of learning technology, and involvement in the implementation of immersive learning. Informants were selected using a purposive sampling technique to obtain rich and in-depth data on teachers' experiences in developing creative learning based on digital skills. Researchers were able to explore the meaning, experiences, and dynamics of learning practices that cannot be adequately explained through quantitative data alone (Patton, 2020).

Quantitative data collection was conducted using a five-point Likert-scale questionnaire designed based on indicators of teacher digital competence and in-depth learning creativity. The teacher digital competence variable includes six indicators: digital literacy, use of learning technology, technology integration in learning, digital communication and collaboration, digital learning evaluation, and technology adaptability. Meanwhile, the in-depth learning creativity variable includes indicators*mindful learning, meaningful learning, joyful learning, creative learning strategies, innovative learning media,*and student engagement. The measurement scale used a range of 1–5, ranging from Strongly Disagree (STS) to Strongly Agree (SS). By distributing the questionnaire to all research respondents, quantitative data was obtained. Respondent data came from the results of high school teachers completing the research instrument, which was analyzed in spreadsheet format.

Interviews were conducted to obtain qualitative data through in-depth, semi-structured interviews with eight teachers. The interviews aimed to explore teachers' experiences regarding the use of digital capabilities to develop creative, immersive learning, including learning strategies, implementation challenges, and teachers' perceptions regarding the use of digital technologies.*mindful, meaningful,* And *joyful learning*. The interview guide is structured flexibly to allow for deeper exploration of answers through techniques*probing*Each interview lasted approximately 45–60 minutes, was recorded with the informant's consent, and transcribed for data analysis purposes.

Documentation was also collected as a supporting data source to strengthen the research findings. This included teacher learning tools, digital media used, teaching modules, learning platforms, and evidence of the use of digital learning media relevant to the implementation of immersive learning. Documentation techniques were used to confirm the correspondence

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

between informant statements and learning practices in the field, thereby enhancing the credibility of the research findings.

Quantitative data analysis used a simple linear regression equation to test the effect of teachers' digital skills on in-depth learning creativity. The analysis stages included descriptive statistics, instrument validity and reliability testing, basic assumption testing, and simple linear regression analysis to obtain the regression coefficient and determination coefficient (R^2), and the level of significance of the relationship between variables. This analysis is used to determine the extent to which teachers' digital skills contribute to in-depth learning creativity.

Meanwhile, qualitative data analysis was conducted using the interactive model of Saldaña, Miles, and Huberman, which includes three main stages: data reduction, data presentation, and conclusion drawing (Miles et al., 2014). Interview data was analyzed using a thematic analysis approach to identify key patterns, categories, and themes emerging from teachers' experiences. The analysis process was carried out through the following stages:*open coding, axial coding,*and categorization of themes related to digital skills, learning creativity, deep learning strategies, and implementation challenges.

To ensure the validity and credibility of the findings, method and source triangulation were used. Method triangulation was carried out through the integration of questionnaire data, interviews, and documentation. Source triangulation was carried out by comparing information between participants from various subjects. To ensure the appropriateness of the data meaning, as well as an audit trail, a member checking technique was used. This was also intended to systematically document the entire research process. This study adhered to the principles of research ethics through voluntary consent (*informed consent*), protection of informant identity, and data is only used for academic purposes.

RESULTS AND DISCUSSION

1. Research Respondent Profile

This study involved 14 teachers from various subjects at a public high school in Surakarta as quantitative respondents. Respondents came from science, social studies, language arts, and arts subject groups with varying teaching experience, levels of learning technology use, and experience participating in digital learning training. In addition, the study also involved eight teachers as informants for in-depth interviews to gain a more contextual understanding of the implementation of digital skills-based in-depth learning.

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

Based on respondent identification results, the majority of teachers have utilized digital technology in their daily learning activities. These technologies include Google Classroom, Quizizz, GeoGebra, Canva, YouTube, interactive PowerPoint, Google Forms, and the school's Learning Management System (LMS). Technology is utilized for material delivery, digital assessments, interactive discussions, learning reflections, and the development of context-based learning projects. However, the level of technology utilization varies among teachers based on their teaching experience, digital readiness, and the characteristics of the subjects they teach.

2. Results of Descriptive Statistical Analysis

The results of the descriptive statistical analysis indicate that teachers' digital skills are high. Most teachers demonstrate strong skills in searching for digital learning resources, selecting learning media, utilizing educational platforms, and integrating technology into learning activities. Teachers also demonstrated a positive attitude toward using technology to enhance learning effectiveness and student engagement.

Meanwhile, the creativity variable for immersive learning also showed a high score. Teachers have begun implementing more reflective, contextual, and engaging learning strategies through the use of interactive media, problem-based discussions, digital assessments, learning videos, and exploration-based projects. However, some teachers still face challenges in time management, student readiness, and adapting more optimal immersive learning strategies.

Table 1. Descriptive Statistics of Research Variables

Variables	N	Mean	Std. Deviation	Minimum	Maximum	Category
Teacher Digital Skills (X)	14	86,64	12,27	51	101	High
Deep Learning Creativity (Y)	14	81,00	7,78	56	94	High

Descriptive statistical analysis showed that the average teacher digital competency score was 86.64, while the average in-depth learning creativity score was 81.00. These scores indicate that teachers generally have a positive tendency to utilize technology to support creative learning.

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

3. Simple Linear Regression Results

Simple linear regression calculations were carried out to determine the influence of teachers' digital abilities (X) on in-depth learning creativity (Y).

3.1 Regression Data Source Table

The following table shows the total scores of the variables teacher digital capability (X) and deep learning creativity (Y) used in the regression analysis.

Table 2. Regression Source Data

Respondent	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14
X	86	85	91	51	89	92	88	90	93	95	98	101	87	87
AND	80	76	90	56	84	83	82	85	87	88	92	94	81	86

3.2 Manual Calculation of Regression Coefficients

The simple linear regression model in this study uses the formula:

$$Y = a + bX$$

Information:

- Y = Deep Learning Creativity
- X = Teacher Digital Skills
- a = constant
- b = regression coefficient

The regression coefficient (b) is calculated using the formula:

$b = \Sigma(X-\bar{X})(Y-\bar{Y}) / \Sigma(X-\bar{X})^2$

Meanwhile, the constant (a) is calculated using the formula:

$a = \bar{Y} - b\bar{X}$

Based on the results of data calculations:

- Rat-rata X ($\bar{X}$) = 86.64
- Rat-rat Y ($\bar{Y}$) = 81.00

The calculation results obtained are:

- b = 0,688
- a = 21,421

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

So the regression equation is obtained:

Y = 21,421 + 0,688X

This equation shows that every one-point increase in a teacher's digital skills increases deep learning creativity by 0.688 points. In other words, the better a teacher's digital skills, the higher the deep learning creativity they develop in the classroom.

3.3 Linear Regression Output Using Excel

Table 3. Model Summary

Regression Statistics	
Multiple R	0,915397
R Square	0,837951
Adjusted R Square	0,824447
Standard Error	3,961276
Observations	14

Results *Model Summary*shows that the R value is 0.915, which means the relationship between teachers' digital abilities and deep learning creativity is in the very strong category. The R Square value of 0.838 indicates that 83.8% of the variation in deep learning creativity is explained by teachers' digital abilities, while 16.2% is influenced by other factors outside the research model, such as teaching experience, school culture, infrastructure support, professional motivation, and other pedagogical factors.

Table 4. ANOVA

ANOVA						
	df	***SS***	***MS***	***F***	***Significance F***	
Regression	1	973,6995	973,6995	62,05186	4.4E-06	
Residual	12	188,3005	15,69171			
Total	13	1162				

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

The ANOVA test results showed an F-value of 62.050 with a significance level of 0.000 (<0.05). This indicates that the regression model is feasible and that teachers' digital skills significantly influence in-depth learning creativity.

Tabel 5. Coefficients

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	21,42083	7,637137	2,804824	0,015901	4,780935	38,06072	4,780935	38,06072
X Variable 1	0,687641	0,087294	7,877301	4.4E-06	0,497444	0,877838	0,497444	0,877838

Based on the coefficient table, the constant value (a) was 21.421 and the regression coefficient (b) was 0.688. The significance value of the teacher's digital ability variable was 0.000 (<0.05), indicating that teacher digital ability had a positive and significant effect on in-depth learning creativity.

Thus, the research hypothesis is accepted, namely that there is a positive and significant influence of teachers' digital abilities on in-depth learning creativity at the high school level.

4. In-depth Interview Results

In-depth interview analysis of 8 teachers resulted in four main themes, namely: (1) digital capabilities as a driver of learning creativity, (2) transformation of in-depth learning strategies, (3) obstacles to implementing digital-based learning, and (4) teacher adaptation strategies in creating learning that*mindful, meaningful,* And *joyful*. These qualitative findings reinforce the quantitative results showing that teachers' digital skills contribute 83.8% to in-depth learning creativity, thus demonstrating that digital competence is a dominant factor in the development of teachers' pedagogical innovation.

Theme 1. Digital Skills as a Driver of Learning Creativity

The majority of teachers stated that digital skills help them develop more creative, varied, and adaptive learning ideas tailored to students' needs. Teachers utilize various platforms such as Quizizz, Canva, GeoGebra, YouTube, Google Classroom, Google Forms, and the school's Learning

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

Management System (LMS) to increase student engagement, clarify learning concepts, and create more engaging learning experiences.

A math teacher explains:

"Previously, I mostly explained things on the board, but now the kids are more engaged because I use GeoGebra and videos. It's easier for them to understand abstract concepts, especially graphs and functions." (G-03)

Another teacher emphasized that technology helps them gain more innovative learning inspiration:

"Technology helps me find ideas. Sometimes I look at learning videos or examples online, then I modify them to better suit my students' personalities." (G-06)

These findings indicate that digital skills are not only related to skills in using technological devices, but also encourage the emergence of pedagogical creativity through the exploration of learning resources, modification of learning strategies, and the development of more contextual media. This finding aligns with quantitative results showing a significant influence of teachers' digital skills on in-depth learning creativity ($\beta = 0.688$; $p < 0.001$). In other words, improvements in teachers' digital skills tend to be followed by improvements in learning creativity.

Theme 2. Transformation of Deep Learning Strategies

Teachers revealed that the use of technology has shifted learning patterns from conventional lecture-based approaches to more active, reflective, collaborative, and experiential learning. Teachers have begun implementing mini-project-based learning, reflective discussions, problem-solving, digital assessments, and visual and multimedia-based material exploration.

One informant explained:

“Now I try to have more discussions, mini-projects, and post-lesson reflections so that students don't just memorize the material, but truly understand it.” (G-01)

Another teacher added:

"When we use interactive quizzes or videos, students are more engaged. They become more active in asking questions and are more focused on the lesson." (G-07)

This change in learning strategy shows a shift in learning practices towards the implementation of in-depth learning (*deep learning*) which emphasizes the process*mindful, meaningful,* And *joyful learning*This finding reinforces the regression results that teachers with better digital skills tend to be more creative in designing contextual and enjoyable learning experiences.

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

Theme 3. Barriers to Implementing Digital-Based Deep Learning

Although teachers demonstrated relatively good digital skills, interviews revealed a number of barriers to developing creative, immersive learning. Key barriers included limited digital infrastructure, student readiness, time constraints, and variations in digital skills among teachers.

Several teachers expressed that limited internet access and learning devices remain obstacles when learning requires intensive use of technology. One teacher said:

"Sometimes the problem is the network. When all students open the app, some are slow, so learning isn't optimal." (G-02)

Another teacher explained that students' readiness for technology-based independent learning is also not evenly distributed:

"Not all students are ready to learn independently using technology. Some still wait for instructions and aren't used to exploring on their own." (G-05)

In addition, time constraints are an important challenge in developing creative learning.

"If you want engaging learning, you do need more preparation. Sometimes creating media or videos takes a lot of time." (G-08)

These findings indicate that although digital capabilities contribute significantly (83.8%) to the creativity of in-depth learning, there are still 16.2% of other factors outside the research model that influence the implementation of creative learning, such as school infrastructure support, organizational culture, teacher motivation, student readiness, and institutional support.

Theme 4. Teacher Adaptation Strategies in Developing Deep Learning

To overcome these challenges, teachers develop adaptation strategies through self-study, professional collaboration, participating in training, and modifying digital learning media.

Most teachers reported gaining learning inspiration through educational webinars, social media, teacher communities, sharing good practices, and learning technology training.

One informant said:

"I often attend webinars or watch learning examples on YouTube, then adapt them to my class situation." (G-04)

Another teacher emphasized the importance of collaboration between teachers:

"We often share media and learning ideas with each other so we don't have to start from scratch. We usually help each other out when new applications are released." (G-06)

This adaptation strategy demonstrates that learning creativity does not develop solely individually, but through a process of professional reflection, continuous learning, and

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

collaboration among teachers. These findings demonstrate that improving teachers' digital skills requires support from the school environment to ensure optimal implementation of immersive learning.

5. Triangulation of Documentation Data

Interview findings were strengthened through documentation of teacher learning tools, including digital teaching modules, interactive presentation media, learning videos, project-based LKPD, use of Google Classroom, digital assessments through Quizizz and Google Forms, as well as evidence of the use of learning visualization applications such as GeoGebra.

Documentation shows that teachers have made various efforts to create more reflective, contextual, and enjoyable learning. In mathematics, teachers utilize GeoGebra to help visualize abstract concepts. Language arts teachers utilize instructional videos and project presentations to increase student participation, while social studies teachers utilize actual case studies and digital quizzes to reinforce context-based learning.

The documentation results demonstrate consistency between quantitative data, interviews, and actual classroom learning practices. Teachers who demonstrated high digital skills scores on the questionnaire also tended to demonstrate higher levels of learning creativity through a variety of media, learning activities, and immersive learning strategies. Thus, data triangulation strengthens the research findings that teachers' digital skills contribute substantially to immersive learning creativity at the high school level.

DISCUSSION

The results of the study indicate that teachers' digital skills have a positive and significant effect on the creativity of deep learning at the high school level. Quantitative findings show an R value of 0.915, indicating a very strong relationship between teachers' digital skills and deep learning creativity. In addition, the coefficient of determination (R^2) value of 0.838 indicates that 83.8% of the variation in deep learning creativity is explained by teachers' digital skills, while 16.2% is influenced by other factors outside the research model. The results of the ANOVA test ($F = 62.050$; $p < 0.001$) show that the regression model has a high level of feasibility, while the regression coefficient value of $\beta = 0.688$ indicates that every increase in teachers' digital skills will be followed by an increase in deep learning creativity. These findings indicate that digital competence is not merely the technical ability to use technological devices, but has become an important factor in the transformation of teachers' pedagogical practices.

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

Research findings show that teachers who have higher digital skills tend to be more creative in designing learning.*mindful, meaningful, and joyful**. Teachers are no longer simply using technology as a presentation tool, but are beginning to integrate it to build more reflective, collaborative, and contextual learning experiences. This is evident in the use of Quizizz, Canva, GeoGebra, learning videos, Google Classroom, and the school's LMS as media to increase student engagement. Teachers utilize technology to help visualize concepts, strengthen formative assessments, and develop project-based and reflective learning. Thus, learning creativity develops through teachers' ability to transform technology into meaningful learning experiences.

These findings align with the Technological Pedagogical Content Knowledge (TPACK) theory developed by Mishra and Koehler (2006), which asserts that the effectiveness of technology-based learning depends on the integration of technological knowledge, pedagogy, and learning materials. In the context of this study, teachers with better digital skills demonstrated greater ability to select media appropriate to the characteristics of the material and students' needs. Mathematics teachers, for example, used GeoGebra to visualize abstract concepts, making it easier for students to understand mathematical relationships. In language and social studies subjects, teachers utilized instructional videos, actual case studies, and digital discussions to strengthen student engagement. These findings suggest that learning creativity emerges when technology is combined with relevant pedagogical strategies.

The research findings support Krumsvik's (2014) study, which found that teachers' digital competence is closely linked to the quality of learning and their professionalism. Teachers with strong digital skills tend to be more adaptable to educational changes and more open to learning innovations. In this study, teachers used technology not only for administrative efficiency but also to develop more interactive and contextual learning strategies. This was reinforced through interviews, which showed that teachers actively explored various digital learning resources and modified learning media to suit students' needs.

Interview findings show that teachers' digital skills foster pedagogical creativity through the exploration of more varied learning ideas. Teachers draw inspiration from webinars, educational social media, professional communities, and sharing good practices with colleagues. One teacher stated that technology makes it easier for them to obtain learning resources and adapt them to classroom conditions. These findings suggest that learning creativity develops through a process of professional reflection and continuous learning. In other words, teachers' digital skills do not develop automatically but are influenced by learning motivation, a collaborative culture, and openness to educational innovation.

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

From a deep learning perspective (*deep learning*), the research results show that the use of technology has contributed to the creation of more effective learning.*mindful, meaningful, and joyful*Teachers are beginning to implement reflective discussions, feedback-based assessments, contextual projects, multimedia explorations, and collaborative activities to strengthen student understanding. The use of instructional videos and interactive quizzes, for example, not only increases student engagement but also helps students understand the relationship between academic concepts and real-life contexts. This finding aligns with research by Suherman et al. (2025), which shows that implementing immersive learning requires teachers' pedagogical readiness and technological adaptability.

However, this study also found that teachers' digital skills do not automatically translate into optimal creativity in immersive learning. Interviews revealed various obstacles, such as limited digital infrastructure, internet network quality, student readiness, time constraints, and variations in digital skills among teachers. Some teachers admitted that creative learning designs require more preparation time than conventional learning. Furthermore, not all students are ready for technology-based independent learning. These findings demonstrate that although digital skills contribute predominantly (83.8%) to learning creativity, successful implementation of immersive learning still requires systemic support.

The findings of this study provide an important perspective: strengthening teachers' digital skills must be accompanied by institutional support and a school culture that supports innovation. Schools need to provide technology training that focuses on pedagogical practice, not just technical skills. Furthermore, collaboration between teachers needs to be strengthened through professional learning communities (*professional learning community*) so teachers can share learning media, implementation experiences, and technology adaptation strategies. These findings demonstrate that in-depth learning transformation relies not solely on individual teacher capabilities but requires a conducive educational ecosystem.

Overall, this study confirms that teachers' digital competency is a significant predictor of the development of creative immersive learning in high schools. The higher a teacher's digital competency, the greater the opportunity for creative, reflective, contextual, and enjoyable learning. Therefore, strengthening teachers' digital competency is a strategic necessity to support the implementation of immersive learning policies in Indonesia.

CONCLUSION

This study shows that teachers' digital skills have a positive and significant effect on the

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

creativity of deep learning at the high school level. The results of a simple linear regression analysis show that teachers' digital skills have a very strong relationship with deep learning creativity (R = 0.915) and contribute 83.8% (R^2 = 0.838) to the variation in deep learning creativity. In addition, the results of the regression test indicate that the research model is suitable for use (F = 62.050; $p < 0.001$) with a regression coefficient value of $\beta = 0.688$, which indicates that every increase in teachers' digital skills will be followed by an increase in deep learning creativity. This finding confirms that teachers' digital skills are a dominant factor in supporting the development of more reflective, contextual, and enjoyable learning.

The quantitative results are supported by qualitative findings, where digital skills help teachers develop various learning innovations through the use of digital platforms such as Quizizz, Canva, GeoGebra, Google Classroom, YouTube, Google Forms, and Learning Management Systems (LMS). Teachers utilize technology to enhance concept visualization, strengthen formative assessment, increase student participation, and build learning experiences based on reflection and problem-solving. Thus, technology is not only used as a learning tool but also as a tool to strengthen teachers' pedagogical creativity in implementing in-depth learning (mindful, meaningful, And joyful learning).

This study also found that the implementation of immersive learning still faces various challenges, including limited digital infrastructure, internet network quality, student readiness, teachers' limited time to develop learning media, and variations in digital skills among teachers. Nevertheless, teachers demonstrated adaptability through independent learning, professional collaboration, participation in training, and utilization of teacher learning communities. Therefore, improving teachers' digital skills needs to be accompanied by strengthening institutional support for more optimal implementation of immersive learning.

REFERENCES

Al-Dawood, I. M. (2025). Levels of Islamic studies teachers' implementation of deep learning-oriented teaching practices in intermediate schools. *Journal of Educational and Social Research, 15*(6), 390–408. https://doi.org/10.36941/jesr-2025-0221

Amabile, T. M. (1983). The social psychology of creativity: A componential conceptualization. *Journal of Personality and Social Psychology, 45*(2), 357–376. https://doi.org/10.1037/0022-3514.45.2.357

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

Barone, S. L. (2025). *The impact of artificial intelligence on creative teaching: An investigation of education in the technological age*. In *Computational Arts and Creative Products: Languages, Spaces and Practices* (pp. 137–152).

Biggs, J., Kember, D., & Leung, D. Y. P. (2001). The revised two-factor Study Process Questionnaire: R-SPQ-2F. *British Journal of Educational Psychology, 71*, 133–149. https://doi.org/10.1348/000709901158433

Cao, Y., & Sun, Y. (2024). The research on the application of deep learning in education. IETI Transactions on Data Analysis and Forecasting, 2(3), 4–11. https://doi.org/10.3991/itdaf.v2i3.51413

Christia, V. R., Manik, N. D. Y., & Maranatha, C. A. (2023). Pendampingan kreativitas guru mengajar dengan menggunakan metode mewarnai dalam meningkatkan minat siswa dalam proses pembelajaran di Sekolah Dasar 36 Menining. *SERVIRE, 3*(1), 35–45. https://doi.org/10.46362/servire.v3i1.132

Deviv, S., Akhmad, N. F., Munir, N. S., Arifuddin, M. S., Nooviar, M. S., Mustamin, Asri, & Astutik, W. (2025). Workshop Pembelajaran "Deep Learning" bagi Guru SMKN 5 Pangkep untuk Peningkatan Proses Pembelajaran. *Jurnal Abdimas Indonesia*, *5*(1), 629-640. https://doi.org/10.34697/jai.v5i1.1418

Dimas Saputra, Chovivah Nur Khaniv, Ine Febrian Maharani, Nurul Wakhidah, Elma Ayu Pratama, & Nur Rohman. (2025). STRATEGI IMPLEMENTASI KURIKULUM BERBASIS DEEP LEARNING DALAM MENINGKATKAN KOMPETENSI PEDAGOGIK GURU DI SD NEGERI 1 DAMAR JATI JEPARA. *Jurnal Psikososial Dan Pendidikan*, *1*(2), 1425–1435. Retrieved from https://publisherqu.com/index.php/psikosospen/article/view/2819

El-Sayed, A. A. I., Alsenany, S. A., Almalki, R. S. E., & Asal, M. G. R. (2025). Fostering creativity-nurturing behaviors among nurse educators: Investigating the interplay between evidence-based practice climate and artificial intelligence competence self-efficacy. *Nurse Education Today, 151*, Article 106734. https://doi.org/10.1016/j.nedt.2025.106734

Ester Marga Retta, Tri Indah Prasasti, Mutiara Aprilia, Nayla Apriani Lubis, Nurul Annisa, & Soraya Firanti Nur. (2025). Peran Guru Menghadapi Hambatan dalam Mengimplementasi Pendekatan Deep Learning di SMPN 11 Medan. CARONG: Jurnal Pendidikan, Sosial Dan Humaniora, 2(4), 560-566. https://doi.org/10.62710/6rz1qz77

Fauziah, P., & Zuhri, M. T. (2025). Pendampingan Guru dalam Penerapan Pendekatan Deep Learning untuk Optimalisasi Capaian Belajar di SD GIS Prima Insani. *Jurnal Medika: Medika*, *4*(4), 1557-1563. https://jmedika.com/index.php/medika/article/view/481

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

Gazawy, Q., Buyrukoglu, S., & Akbas, A. (2023). Deep learning for enhanced education quality: Assessing student engagement and emotional states. *2023 Innovations in Intelligent Systems and Applications Conference (ASYU 2023)*. https://doi.org/10.1109/ASYU58738.2023.10296748

Haditia, M. ., Sinaga, M. N. A. ., Soepriyanto, Y. ., Purnomo, P., & Ma'ruf, R. A. . (2024). Perbandingan Efektivitas Metode Pembelajaran Tradisional dan Digital dalam Peningkatan Kompetensi Mengaji di Sekolah Lembaga Kompetensi Mengaji. *JIIP - Jurnal Ilmiah Ilmu Pendidikan*, *7*(7), 6447-6453. https://doi.org/10.54371/jiip.v7i7.5198

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

Manalo, E. (2019). *Deeper learning, dialogic learning, and critical thinking: Research-based strategies for the classroom*. Routledge. https://doi.org/10.4324/9780429323058

Manalu, A., Silaban, W., Rajagukguk, T. P., & Purba, I. D. (2025). Penguatan Pemahaman Awal Guru tentang Pendekatan Deep Learning. AJAD: Jurnal Pengabdian kepada Masyarakat, 5(2), 273-277. https://doi.org/10.59431/ajad.v5i2.583

McMahon, T. (2006). Teaching for more effective learning: Seven maxims for practice. *Radiography, 12*(1), 34–44. https://doi.org/10.1016/j.radi.2005.03.009

Miles, M. B., Huberman, A. M., & Saldaña, J. (2014). *Qualitative data analysis: A methods sourcebook* (3rd ed.). Sage Publications.

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record, 108*(6), 1017–1054. https://doi.org/10.1111/j.1467-9620.2006.00684.x

Ng, W. (2012). *Can we teach digital natives digital literacy?* Computers & Education, 59(3), 1065–1078. https://doi.org/10.1016/j.compedu.2012.04.016

Nourma Oktaviarini, Nugrananda Janattaka, & Nurna Listya Purnama Sari. (2026). Sosialisasi Deep Learning dan Penerapannya dalam Implementasi Pembelajaran sebagai Upaya Peningkatan Kompetensi Guru SDN Talun 05. *BERBAKTI: Jurnal Pengabdian Kepada Masyarakat*, *2*(03), 170–175. Retrieved from https://jurnal.mifandimandiri.com/index.php/berbakti/article/view/308

Nurjanah, S., & Suryadi, A. (2025). Analisis Kesiapan Guru Dalam Menerapkan Pendekatan Deep Learning Pada Pembelajaran Sejarah Kelas X SMA Sint Louis. *Jurnal Kajian Ilmu Pendidikan (JKIP)*, *6*(3), 943-953. https://doi.org/10.55583/jkip.v6i3.1497

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

Organisation for Economic Co-operation and Development. (2021). *Teachers and school leaders as valued professionals: OECD indicators*. OECD Publishing.

Pahrudin, A., Aridan, M., & Barata, M. (2025). Teacher readiness for deep learning in Islamic education: A Rasch model analysis of challenges and opportunities. *Journal of Teaching and Learning, 19*(4). https://doi.org/10.22329/jtl.v19i4.9573

Pan, Q., Zhou, J., Yang, D., Shi, D., Wang, D., Chen, X., ... & Liu, J. (2023). Mapping knowledge domain analysis in deep learning research of global education. Sustainability, 15(4), 3097. https://doi.org/10.3390/su15043097

Pandang, A. (2025). Implementation of deep learning pedagogy in curriculum reform: Primary school teachers' perspectives in Indonesia. *International Journal of Learning, Teaching and Educational Research, 24*(11). https://doi.org/10.26803/ijlter.24.11.29

Pietsch, M., Adams, D., Bellibaş, M. Ş., & Muniandy, V. (2026). Pedagogical knowledge absorptive capacity and LMX as proactive and strategic approaches to work engagement and teacher creativity: A job demands-resource perspective. *Educational Studies*. Advance online publication. https://doi.org/10.1080/03055698.2026.2653769

Praktik Manajemen Kelas dalam Pembelajaran Deep Learning Keterampilan Guru Abad 21 yang Kreatif dan Inovatif. (2025). *Jurnal Altifani Penelitian Dan Pengabdian Kepada Masyarakat*, *5*(6), 1525-1535. https://doi.org/10.59395/altifani.v5i6.977

Prensky, M. (2001). Digital natives, digital immigrants. *On the Horizon, 9*(5), 1–6. https://doi.org/10.1108/10748120110424816

Shaik, R., Laxmikanth, P., Narayanarao, K., Akhila, N., Pavithra, P., & Prasad, K. (2025). A deep learning driven framework for teaching strategy based on student behavior analysis for recommending strategies. *2025 4th OPJU International Technology Conference on Smart Computing for Innovation and Advancement in Industry 5.0 (OTCON 2025)*. https://doi.org/10.1109/OTCON65728.2025.11070843

Shulman, L. S. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review, 57*(1), 1–22. https://doi.org/10.17763/haer.57.1.j463w79r56455411

Song, X., Yang, X., Wang, Q., Su, Y., & Hong, J. (2022). The relationship between teacher's gender and deep learning strategy: The mediating role of deep learning motivation. *Psychology in the Schools*. https://doi.org/10.1002/pits.22694

Suherman, A., Supriyadi, T., Safari, I., Saptani, E., Fauzi, R., Sudirjo, E., Komiljon O'g'li, T., & Abdisamiyevich, X. (2025). Bridging teacher readiness and deep learning-based teaching practice: Assessing the effectiveness of the ACTIVE model for enhancing teacher pedagogy.

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

International Research Journal of Multidisciplinary Scope. https://doi.org/10.47857/irjms.2025.v06i04.05526

Sulianto, J., Prayito, M., Buchori, A., & Sumarno, S. (2026). Sebuah Peningkatan Kompetensi Guru Sekolah Dasar melalui Pelatihan Pembuatan Perangkat Pembelajaran Berbasis Deep Learning . *Archive: Jurnal Pengabdian Kepada Masyarakat*, *5*(2), 527–538. https://doi.org/10.55506/arch.v5i2.264

Suradin, S., Rasul, M. S., & Omar, M. (2025). Identifying challenges of cultivating creativity in product design. *International Journal of Evaluation and Research in Education, 14*(2), 1488–1495. https://doi.org/10.11591/ijere.v14i2.29568

Tierney, P., & Farmer, S. M. (2002). Creative self-efficacy: Its potential antecedents and relationship to creative performance. *Academy of Management Journal, 45*(6), 1137–1148. https://doi.org/10.2307/3069429

Turner, S. (2020). Novel and engaging versus boring and stagnating: How do pupils and teachers alike perceive the state of creativity in secondary schools? In *Creativity and the Child: Interdisciplinary Perspectives* (pp. 117–127). Brill. https://doi.org/10.1163/9781848880061_012

Vera Rosalina Bulu, Martha Kristina Kota, Livia Eunike Paut, Habibi Musa, Juliana M. Nenohai, & Sania Natonis. (2026). Penguatan Kompetensi Guru Melalui Pendampingan Pembuatan Modul Ajar Inovatif Dengan Pendekatan Deep Learning Menggunakan Model CERDAS. *Jurnal Abdi Masyarakat Dan Pemberdayaan Inovatif*, *2*(2), 18-33. https://doi.org/10.64690/jampi.v2i2.725

Waluyo, W., Ulfa, M., Nahdiyah, F., & Luthfi, A. (2025). Transformasi peran guru sebagai fasilitator deep learning di kelas. *Journal Sains Student Research*, *3*(4), 724-735. https://ejurnal.kampusakademik.co.id/index.php/jssr/article/view/5470

Wang, G., & Wang, Z. (2025). Utilising an interactive deep learning framework to enhance the effectiveness of intelligent teaching practices. *Decision Making: Applications in Management and Engineering*. https://doi.org/10.31181/dmame8120251333

Wang, J. (2023). The teaching practice of ideological and political courses in college based on deep learning. *Journal of Combinatorial Mathematics and Combinatorial Computing*.

Wang, L., & Kokotsaki, D. (2018). Primary school teachers' conceptions of creativity in teaching English as a foreign language (EFL) in China. *Thinking Skills and Creativity, 29*, 115–130. https://doi.org/10.1016/j.tsc.2018.06.002

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

Weng, C., Chen, C., & Ai, X. (2022). A pedagogical study on promoting students' deep learning through design-based learning. International Journal of Technology and Design Education, 33(4), 1653–1674. https://doi.org/10.1007/s10798-022-09789-4

Zainil, M., Netrawati, N., Arwin, A., Kenedi, A. K., Suherman, D. S., & Mardin, A. (2025). Pelatihan Pembelajaran Deep Learning Berbasis STEAM untuk Guru Sekolah Dasar. *Jurnal Pengabdian Masyarakat (ABDIRA)*, *5*(3), 1278-1287. https://doi.org/10.31004/abdira.v5i3.937

Zhao, Z. (2025). Convolutional neural network-based facial expression recognition for student engagement evaluation in higher vocational English classroom. *2025 4th IEEE International Conference on Distributed Computing and Electrical Circuits and Electronics (ICDCECE 2025)*. https://doi.org/10.1109/ICDCECE65353.2025.11035636

Zhou, Q., Zhang, H., & Li, F. (2024). The impact of online interactive teaching on university students' deep learning—the perspective of self-determination. Education Sciences, 14(6), 664. https://doi.org/10.3390/educsci14060664

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License