



## Literature Review on Pedagogical Skills, Technology, and Digitalization

Alif Ringga Persada<sup>1</sup>, A. Sobandi<sup>2</sup>

### Abstract

The purpose of this study is to present an overview of the literature review related to pedagogical knowledge, technology and digitalization. The method used in this research is a qualitative research method where descriptive analysis of existing literature research is carried out. The data sources used in this study are journal articles on pedagogical knowledge, technology and digitalization, the results of which show that pedagogical knowledge plays an important role in the utilization of technology and digitalization in the classroom context. The literature review emphasized that a strong understanding of the principles of effective education and pedagogy is a necessary foundation for educators to integrate technology and digitalization into their classroom practices. With the help of pedagogical information, it enables educators to plan practical learning experiences using technological tools that are appropriate to students' needs and characteristics. In addition, literary research also shows that technology and digitalization can provide great benefits in an educational context. Appropriate use of technology can increase student engagement, encourage active and collaborative learning, and improve access to educational resources. Moreover, digitization can also change the way educators manage and assess learning. With the help of these articles, the relationship between pedagogical knowledge, technology and digitalization in educational contexts can be further explored. The purpose of this study is to describe literature research on pedagogical knowledge, technology and digitalization. The method used in this research is a qualitative research method where a descriptive analysis of the literature review is conducted. Journal articles related to pedagogical knowledge, technology and digitalization were used as data sources. The results of this study indicate that there are 24 articles that serve as literature research and can be used as references in the study of pedagogical skills, technology and digitalization.

**Keywords:** *Pedagogical Skills, Technology, Digitalization*

### A. Introduction

The rapid development of information and communication technology has significantly impacted the world of education (Afshari et al., 2009). Digital transformation in education is not something that has happened recently, digital transformation in education is an issue that needs to be considered by education stakeholders, especially in preparing infrastructure and facilities (Purnasari & Sadewo, 2020). Digital transformation in the context of education can be an opportunity or an obstacle depending on the stakeholders of educational institutions.

This change is not just a change in curriculum content but a change in pedagogy namely changes that encourage the birth of technology-based teaching instead of traditional teaching (Rahayuningsih & Muhtar, 2022). This condition encourages educators to be aware of the era's

---

<sup>1</sup> Universitas Pendidikan Indonesia, IAIN Syekh Nurjati Cirebon, Indonesia [alifringgapersada1@gmail.com](mailto:alifringgapersada1@gmail.com)

<sup>2</sup> Universitas Pendidikan Indonesia, Indonesia [ade@upi.edu](mailto:ade@upi.edu)

development and to develop and improve their competence, including pedagogical competence. This condition encourages educators to be aware of the era's development and to develop and improve their competence, including pedagogical competence. The digitization of education has changed the old way of learning into a new way of utilizing technology and learning applications. Learning can be done anytime, anywhere, not limited by space and time, and does not have to be face-to-face (Tari & Hutapea, 2020). The digital era has affected the way of learning, teaching, and evaluation in schools and higher education (Kurnianingsih et al., 2017). Because of this, it is necessary for educators to innovate and adjust to ever-more complex technological changes.

New models and orientations in 21st-century education emphasize creative education as a starting point in 21st-century education that can encourage significant changes in the role of educators, public relations, technology, and professionalization of educators. 21st-century educators must know how to provide learning opportunities for students supported by technological advances and understand how technology works to support learning (Rahayuningsih & Muhtar, 2022). By taking advantage of the current technology's rapid advancement, educators need to become digital educators with a working knowledge of and skill with computers, literacy abilities for creative learning, and a working knowledge of digital technology for learning in order to provide resources and meaning for their students.

There are many different digital information sources available today as a result of the quick development of the digital world. Students in general and teachers in particular need to be proficient in digital literacy. Today's instructors will have their performance called into question if they lack appropriate digital literacy. By using the current technology's quick advancement, educators must become digital educators who are able to utilize computers, literacy abilities for creative learning, and knowledge of digital technology to give their students provisions and meaning. Educators must master digital literacy to ease students' learning in the current era as the basis of pedagogic competence. (Ting, 2015).

Pedagogic competence is the ability to manage, understand, design, implement and evaluate learning to actualize the potential in students (Frankena, 2010). Thus, the pedagogical ability of educators is a challenging thing because the quality of educators must be above average—pedagogical competence is a competency that distinguishes the teaching profession from other professions. One of the scopes of this competence is the absolute mastery of educators of learning models, methods, strategies, and techniques and being able to apply them in the teaching and learning process. Educators' competence in designing appropriate and appropriate learning is needed to achieve the set goals, but in reality, many educators have not fulfilled or achieved pedagogical competence. Educators' skills in managing learning still need to be improved, especially in mastering technology and using it in learning

## **B. Methods**

A literature review was used as the research methodology with the literature review method as the initial strategy. Literature review involves searching and researching through various literature sources such as books, journals, and other publications relevant to the research topic. The aim of the literature review is to generate articles about a particular topic or issue (Marzali, 2016). In the context of writing scientific works such as theses, journals, and dissertations, researchers conducted literature reviews by finding literary works that are related to research topics and problems. They also look for information about the community and research location,

and theories that have been used and developed by others that are related to the research topic. The literature review also examined the research techniques applied in the previous studies. (Marzali, 2016). By conducting a comprehensive literature review, researchers can better understand the research topic, find existing research gaps, and identify relevant conceptual frameworks. Literature reviews also help researchers to avoid duplicating previously conducted research and ensure that their research makes a meaningful contribution to the relevant field of knowledge.

The literature review is conducted with the understanding that knowledge is constantly evolving and growing over time. We can learn from the previous research that the previous researchers have done. Therefore, this research is one of many that conducted a study on this topic, community, and region. There are two primary purposes of a literature review. First, a literature review aims to produce a writing that introduces new research on a particular topic to practitioners in the field. Such reviews can be published for the public interest. For example, there are the Annual Review of Anthropology, the Annual Review of Sociology, and such reviews. Those who are just starting as novice researchers in a particular topic can use these annual publications as initial reading material (Tjahjono, H., 2018).

The second purpose of the literature review is for the sake of our research project. In this context, a literature review aims to broaden our understanding of the research topic, help formulate the research problem, and help determine the appropriate theories and methods to use in our research. By studying studies conducted by others, we can decide whether we want to adopt, replicate, or criticize a particular study. The previous literature reviews are used as a comparison for our research. By criticizing the work of others, we can create something new. This paper discussed how previously written literature reviews could be used to conduct new research, especially for students who want to write final scientific papers such as journals, theses, or dissertations (Marzali, 2016). Based on the explanation above, the researcher used a literature review using articles related to teachers, pedagogical skills, and technology.

### **C. Findings and Discussion**

In the initial stage, a thorough selection of articles was made based on the keywords contained in the title, namely pedagogical technology skills in the digital era. From the total of 30 articles, 24 were matched, while the remaining 6 articles were discarded because the variables did not match the title. The table of the 24 articles can be seen below.

<b>No</b>	<b>Author(s)</b>	<b>Year Published</b>	<b>Title</b>	<b>Journal</b>	<b>Page</b>
1	Regita Andriani, Ditha Aulia Andriany, Sifa Kiamul Lailia	2021	Meningkatkan Kualitas Guru Dalam Menguasai Tik Melalui Program Microsoft Partner In Learning (Pil) Dan Aplikasi Moodle	Current Reaserch in Education: Conference Series Journal	1-6

No	Author(s)	Year Published	Title	Journal	Page
2	Gina Amalia, Dan Lilis Karnita Sholeha	2021	Analisis Kompetensi Tik Guru Di Era Revolusi Industri 4.0 Dalam Memanfaatkan Media Pembelajaran Berbasis Teknologi (Studi Kasus Pada Sdn Cangkuang 01)	Frima	534-542
3	Ahmad Zabidi	2019	Kreativitas Guru Menggunakan Laptop Dan Internet Sebagai Media Pembelajaran Di Sd Negeri Bawen, Kecamatan Bawen, Kabupaten Semarang.	Teknologi Jurnal Inspirasi	128-144
4	Endi Rochaendi, Andi Wahyudi, Dan Riki Perdana	2021	Kompetensi Teknologi, Pedagogi, Dan Konten Guru Sd Negeri Dan Swasta Di Kota Cimahi, Jawa Barat	Jurnal Pendidikan Dasar Indonesia	-
5	Yesi Anita, Arwin, Syafri Ahmad, Yullys Helsa, Ary Kiswanto Kenedi	2022	Pelatihan Pengembangan Bahan Ajar Digital Berbasis Hots Sebagai Bentuk Pembelajaran Di Era Revolusi Industri 4.0 Untuk Guru Sekolah Dasar	Jurnal Pengabdian Masyarakat	59-68
6	Nurul Adlina	2022	Inovasi Pembelajaran Di Masa Pandemi Covid-19 Dengan Pendekatan	Jsim: Jurnal Ilmu Sosial Dan Pendidikan	619-626

No	Author(s)	Year Published	Title	Journal	Page
7	Suci Ramadhanti Febriani <sup>1</sup> Dan Arifka Mahmudi <sup>2</sup>	2021	Steam Di Era Society 5.0 Implementasi Pembelajaran Kooperatif Dan Independen Pada Keterampilan Menulis Di Era Revolusi Industri 4.0	Al-Mi'yar	60-72
8	Windarto	2021	Kode Etik Guru Dalam Pengaplikasian Media Pembelajaran Online Pai Di Era Revolusi Industri 4.0	Al-Qolam:Jurnal Ilmiah Dan Kemasyarakatan	15-27
9	Khairuddin Tampubolon <sup>1*</sup> , Elazhari <sup>2</sup> , Fider Lumban Batu <sup>3</sup>	2021	Analisis Dan Penerapan Tiga Elemen Sistem Pembelajaran Pada Era Industri 4.0 Di Universitas Pembinaan Masyarakat Indonesia	All Fields Of Science J-Las	153-163
10	Yesi Anita 1), Arwin 2), Syafri Ahmad 3), Yullys Helsa 4), Ary Kiswanto Kenedi 5)	2022	Pelatihan Pengembangan Bahan Ajar Digital Berbasis Hots Sebagai Bentuk Pembelajaran Di Era Revolusi Industri 4.0 Untuk Guru Sekolah Dasar	Jurnal Pengabdian Masyarakat	59-68
11	Carmen Marta-Lazo, Diane E. Meigs-Frau, And Sara Osuna-Acedo.	2019	A Collaborative Digital Pedagogy Experience In The Tmooc "Step By Step"	Australasia Journal Of Education Tecnology	111-127
12	Christine Greenhow, Cathy Lewin, And K. Bret Staudt Willet.	2021	The Educational Response To Covid-19 Across Two Countries: A Critical	Journal Of Education Tecnology	2-41

No	Author(s)	Year Published	Title	Journal	Page
13	Janne Olavi Vaataja Dan Heli Ruokamo	2021	Examination Of Initial Digital Pedagogy Adoption Conceptualizing Dimensions And A Model For Digital Pedagogy	Journal Of Pasific Psychology	2-12
14	Denise Leahy, Dudley Dolan	2010	Digital Literacy: A Vital Competence For 2010?	SCSS	211-221
15	Lucy Lunevich	2021	Critical Digital Pedagogy And Innovative Model, Revisiting Plato And Kant: An Environmental Approach To Teaching In The Digital Era	Creative Education	2011-2024
16		2018	Developing Digital Pedagogy Through Learning Design: An Activity Theory Perspective	Journal Of Education Tecnology	1311-1144
17	Dwiyanti Puspitasari, Elya Umi Hanik, Emilia Safitri, Hema Rizkyana Firdaus, Maurin Pratiwi5, Reza Nidaul Innayah	2022	Integrasi Pendekatan Tpack Dalam Melaksanakan Pembelajaran Era Digital Di Sikl (Sekolah Indonesia Kuala Lumpur)	Basica:Journal Of Art And Science In Primary Education	-
18	Sri Handayani, Riyani, Khala Kirana	2020	Pendekatan Joyful Learning Dalam Pembelajaran Microteaching Di Era Revolusi Industri 4.0	-	-
19	Virginia Rodés, Mariana Porta,	2021	Teacher Education In The Emergency:	Journal Of Interactive Media In Education	1-14

No	Author(s)	Year Published	Title	Journal	Page
	Lucia Garófalo, Carolina Rodríguez Enríquez		A Mooc-Inspired Teacher Professional Development Strategy Grounded In Critical Digital Pedagogy And Pedagogy Of Care		
20	Septi Purfitasaria, Masrukhib, Titi Prihatin, Sungkowo Edy Mulyono	2019	Digital Pedagogy Sebagai Pendekatan Pembelajaran Di Era Industri 4.0	Seminar Nasional Pasca Sarjana 2019	806-811
21	Susilahudin Putrawangsa & Uswatun Hasanah	2018	Integrasi Teknologi Digital Dalam Pembelajaran Di Era Industri 4.0. Kajian Dari Perspektif Pembelajaran Matematika	Jurnal Pemikiran Dan Penelitian Pendidikan	42-53
22	Winda Sulistyarini Dan Siti Fatonah. Winda Sulistyarini	2022	"Pengaruh Pemahaman Literasi Digital Dan Pemanfaatan Media Pembelajaran Terhadap Kompetensi Pedagogik Guru Era Digital Learning	Journal Of Educational Learning And Innovation (Elia)	42-72
23	Ketut Queena Fredlina And Putri Anugrah Cahya Dewi.	2022	Digitalisasi Konten Pembelajaran Di Sma Negeri 1 Petang, Bali".	Jiip (Jurnal Ilmiah Ilmu Pendidikan).	1-2
24	Pebria Dheni Purnasari Dan Yosua Damas Sadewo	2021	Strategi Pembelajaran Pendidikan Dasar Di Perbatasan Pada Era Digital	Jurnal Basicedu	3089 - 3100

In the first article which was written by Andriani, Andriany, and Lailia (2021), the literature research method was used to collect data relevant to the study's topic, namely innovations to improve the quality of teachers in Indonesia. The data were obtained from literature sources such as journals, ebooks, and news on social media. From these data, the author could convey their opinions, arguments, or ideas based on the researcher's thoughts, which are written in this paper. The literature research method provides accuracy, reliability, and a comprehensive perspective. Generally, the article concludes that the quality of teachers in Information and Communication Technology (ICT) still needs to improve in Indonesia. The author reveals that this problem requires an effective solution. In the article, several findings indicate a problem in the quality of teachers' ICT in Indonesia. Those findings include: 1. The low quality of teachers' ICT: In general, the study showed that teachers in Indonesia still have a low level of quality in using information and communication technology. This can affect the effectiveness of teaching and learning in the classroom. 2. The lack of teachers' knowledge and skills in ICT: Findings show that many teachers need more knowledge and skills in using technology. They may need to become more familiar with relevant ICT tools and applications to use for teaching. 3. Limited teacher training and development in ICT: Findings also reveal a need for adequate training and development in ICT, which plays an essential factor in the low quality of teachers. Teachers need a systematic and continuous approach to improving their knowledge and skills for ICT. 4. The absence of ICT in teachers' performance evaluation: Existing teacher performance evaluations still need to integrate technology fully. This may lead to a need for more incentives and motivation for teachers to improve their ability to use technology in learning. These findings indicate a problem in the quality of teachers' ICT in Indonesia, which requires appropriate actions and solutions to develop. Two solutions offered are to increase the intensity of training and develop teacher competencies in ICT and improve the teachers' performance evaluation system by better integrating technology. This article emphasizes the importance of improving the quality of teachers in ICT and provides concrete recommendations to achieve this goal.

The next article is the second article which was written by Amalia and Sholeha (2021) used qualitative research methods with a descriptive approach. The descriptive method describes the characteristics and conditions of the research subject without conducting hypothesis testing or statistical generalization. The data collection techniques used includes interviews, observations, and literature studies. The data used consists of primary data obtained directly from the source and secondary data that already been found and is available. By combining these methods and techniques, this study aims to gain an in-depth and comprehensive understanding of the phenomenon of the study. The researcher of the study hopes that the result of the study able to provide a detailed and contextualized picture of the observed topic. Based on the results of interviews and observations, it was found that there are several problems in using technology-based learning media at SDN Cangkuang 01: 1. Limited technological devices available. This can lead to limited access for teachers to use these devices in learning. 2. Limited internet access: The limited internet access at school is also an obstacle in the use of technology-based learning. 3. Devices that only sometimes function properly: Some teachers face obstacles with devices that often experience technical problems or cannot function properly. 4. Lack of ability in operating technological devices and applications: Although teachers' level of ICT competence is considered quite well, it was found that not all teachers have adequate skills in operating technology devices and utilizing various applications or software to support the teaching process. 5. Lack of training or mentoring: Another thing that was found in the study is that there is a lack of training or mentoring that provided to the teachers in developing their ability to use

technology-based learning. Teachers need to receive adequate training or mentoring to optimize the potential use of technology in learning. To solve the mentioned problems, improving technology device facilities in schools, such as increasing the number of devices and improving the condition of existing devices, is necessary. In addition, adequate training and mentoring are essential to improve teachers' ability to utilize information and communication technology in learning.

In the third article which was written by Zabidi (2019), the field research method was applied, where researchers are directly involved in the field to observe the activities, conduct interviews, and document the activities related to the research topic. This study aims to identify and understand the level of teacher creativity in utilizing the internet and laptops as learning tools for Islamic Religion Education (IRE) in Elementary Schools in Bawen District, Semarang Regency, in the 2018/2019 school year. The results of this study provide an overview of how far have the teachers in this school utilize the internet and laptops in Islamic Education teaching. This study also revealed the level of creativity of the teachers in utilizing the technology. From the observations and interviews, the researchers identified various methods and strategies used by the teachers to improve IRE teaching by utilizing the Internet and laptops. Some examples of creativity found include using online resources, using interactive educational applications, and developing digital learning materials. However, there are issues found regarding this article;

1. Limited internet access in the school environment could be an obstacle in utilizing online resources and presenting interactive learning materials. The suggested solution is to improve internet infrastructure in schools and find alternative offline resources that can be downloaded.
2. Limited technology skills: Not all teachers have adequate technological understanding and skills. This can hinder the effective use of the internet and laptops. The solution is to provide additional training and education to teachers to improve their understanding and skills in utilizing technology.
3. Limited relevant digital resources: Finding appropriate digital resources for IRE learning takes time and effort. The recommended solution is to develop and collect quality digital resources that fit the IRE curriculum through collaboration with related parties.

In the 4th article written by Rochaendi, Wahyudi, and Perdana (2021), used quantitative methods with descriptive and verification approaches. The research sample uses 240 elementary school teachers that were selected using a proportional random sampling technique with a total population of 596 elementary school teachers in North Cimahi District, Cimahi City, West Java Province. The information was gathered through a survey that has been validated and reliability-tested through Google Forms. The collected data were analyzed using descriptive and inferential statistical analysis techniques, such as validity test, reliability test, normality test, multiple linear regression test, and coefficient of determination test. The results showed that the average TPACK competency achievement of elementary school teachers was 5.373, with the outstanding value that can be achieved being 7.000. The most dominant factors in shaping elementary teachers' competencies are technology-based pedagogical knowledge (TPK), content knowledge (CK), and technological knowledge (TK). In addition, this study successfully developed a TPACK development model suitable for elementary teachers through confirmatory factor analysis (CFA) based on Partial Least Square (PLS). The TPACK competencies of primary school teachers in incorporating technology into learning can be developed using this methodology. The research document also presents the profile of primary school teachers as the respondents based on gender and school status, which provides additional information about the

characteristics of the research sample. Overall, this study provides an overview of the TPACK competencies of primary school teachers in North Cimahi Sub-district, Cimahi City, West Java Province, and the factors that influence these competencies. The results of this study can serve as a foundation for developing training and professional development programs for primary school teachers to improve their TPACK competencies.

The 5th article which was written by Anita, Arwin, Ahmad, Helsa, and Kiswanto (2022), explained about the training that was held virtually through the ZOOM Meeting application, with 25 participants who were primary school teachers in the Lubuk Kilangan sub-district. The methods applied included HOTS seminars, HOTS learning implementation training, and HOTS-based teaching materials development training. 1. The training successfully improved teachers' knowledge and skills in implementing the HOTS-based learning process. The teachers gained a better understanding of HOTS concepts and strategies that can be used to develop higher-order thinking skills for the students. 2. The training also successfully improved teachers' skills in developing HOTS-based teaching materials. The teachers were equipped with skills in designing and developing learning materials that encourage higher-order thinking for students, with an emphasis on paraphrasing. 3. The results of this training concluded that there was a development in teachers' knowledge and skills in implementing HOTS-based learning processes as well as teachers' skills in developing HOTS-based teaching materials. 4. This training benefits primary school teachers in Lubuk Kilangan sub-district, as they can implement HOTS-based learning more effectively. Improved learning quality is expected to enrich students' learning experience and improve their ability to think critically, communicate, and solve problems. 5. This training is expected to be continued periodically to continuously improve teachers' knowledge and skills in implementing the HOTS-based learning process. Continuous training provides opportunities for teachers to continue in developing their skills and provide long-term benefits for students in terms of higher-quality education.

6th article which was written by Adlina (2022), uses a literature study or literature review method. A literature study is a research approach that involves reviewing various journals, books, and literature sources relevant to the discussed research topic. Through literature studies, researchers will summarize, analyze, and interpret concepts and theories relevant to the research being conducted. The result of the study showed that STEAM learning can increase students' creativity in thinking, problem-solving, and scientific thinking. STEAM learning can be applied through various learning methods, such as project-based learning, inquiry, encounters, and problems. The STEAM learning approach encourages collaboration between teachers and students, where teachers act as the facilitators and students are at the center of the learning process. During the COVID-19 pandemic, STEAM learning can be done online by utilizing technology and exploring the surrounding environment. 1. Enhancing students' creativity: STEAM learning provides opportunities for students to develop their creativity in thinking, problem-solving, and scientific thinking. Through an approach that emphasizes independent exploration and discovery, students are encouraged to think critically, find innovative solutions, and face complex challenges. 2. STEAM learning method: STEAM learning can be implemented through various integrated learning methods. Some methods commonly used in STEAM learning include: - Project-based learning: Students work on real projects that require applying knowledge and skills from different disciplines. They are involved in the project's planning, design, and implementation, enabling them to connect theoretical concepts with practical applications. -Inquiry-based learning: Students can explore questions and problems through experimentation, observation, and investigation. They learn through discovery and problem-

solving, which helps improve their scientific thinking and questioning skills. -Encounter-based learning: Students participate in group or team discussions to discuss ideas, share knowledge and build shared understanding. They learn through social and collaborative interaction, encouraging critical thinking and communication skills. -Problem-based learning: Students are exposed to real problems that require solving through analyzing, planning, and implementing solutions. They learn through concrete problem solving, which develops critical thinking skills and creativity. 3. Teacher and student roles: In STEAM learning, the role of the teacher changes to a facilitator who guides and supports students in the learning process. The teacher is no longer the sole source of knowledge but helps students develop their understanding through exploration, discussion, and reflection. Students become the center of the learning process, actively involved in experimentation, discovery, and application of concepts. 4. STEAM learning in online learning: During the COVID-19 pandemic, STEAM learning can be done online using technology. Teachers can use online learning platforms, video conferencing, or digital resources to deliver materials.

The 7th article by Febriani and Mahmudi (2021) used a qualitative research approach. The researcher interviewed Arabic lecturers to obtain information about how Arabic learning is conducted online. Documentation was also used to obtain information regarding the learning process, including lesson plans and academic handbooks. In conclusion, Cooperative Independent Learning (CIL) is a learning method that combines the theoretical principles of reconstructionism, cognitivism, and 21st-century learning. It emphasizes the importance of student collaboration and independence in learning. In CIL, students are encouraged to actively collaborate, support each other, and build knowledge together. They are also invited to engage in problem-solving, reflection, and critical analysis through interaction with fellow students and applying concepts in real situations. In addition, this method develops 21st-century skills such as problem-solving, cooperation, communication, and digital literacy through technology and task-based projects. By combining these three theories, CIL provides a holistic and student-oriented learning experience, preparing them to face the demands of the modern world and develop relevant skills.

In 8th article by Windarto (2021), was conducted using method that involves an in-depth review of relevant literature on the use of online learning media in Islamic religious education, teachers' code of ethics, and industrial revolution 4.0. Researchers will collect, read and analyze journal articles, books, research reports, and other literature sources to build a solid theoretical foundation. The conventional learning is needed to prepare students to face the demands of the industrial revolution era 4.0. Therefore, technological intervention has become inseparable from education today. However, in the context of Islamic education, there are challenges in dealing with innovations that changes the paradigm of Islamic education, which is more oriented towards conventional materials, curriculum, methods, and learning methods. In facing these changes, teachers, as the primary agents of education, must uphold the code of ethics and develop themselves in adapting technology and online learning media. Selection of suitable learning media, such as the Kahoot game or Edmodo social media is also the key to the success of technology-based learning. Teachers must implement online learning by utilizing relevant media and improving interactive communication between teachers and learners. In the context of online learning, the Asynchronous e-learning method can also be applied, where students respond to the material delivered by the teacher through the LMS application at different times. Overall, the utilization of technology-based educational resources in the era of the fourth industrial revolution presents chances to raise the standard of instruction. However, challenges such as

accessibility, interaction, content quality, teacher expertise, and supervision need to be addressed with appropriate solutions so that online learning can be effective and efficient in achieving educational goals.

In 9th study by Tampubolon, Elazhari, and Batu (2021), the quantitative approach was used to analyze data and information obtained from respondents through numbers. Parametric statistical analysis is used to analyze the data. Microsoft Excel and Microsoft Word software in the Office 2010 package were used to process the data and present the analysis results. 1. Results of Analysis of Students' Knowledge of the Industrial Era 4.0: This study revealed the level of knowledge UPMI students possess about the concepts, technologies, and trends associated with the Industrial Age 4.0. The results of this analysis provided an overview of the extent to which students understand the concept. 2. Identification of Difficulties Faced by Students: This research identified obstacles or difficulties faced by UPMI students in preparing for the Industrial Age 4.0. For example, students may experience difficulties in acquiring specialized skills relevant to Industry 4.0 or keeping up with the latest technological developments. 3. Learning System Implementation Plan: Based on the results of the analysis and identification of difficulties faced by students, this research provided recommendations or plans for implementing a learning system that is suitable for the Industrial Age 4.0 at UPMI. Such plans included developing relevant curricula, using technology in the learning process, or training to improve the skills needed in Industry 4.0.

In 10th article written by Anita, Arwin, Ahmad, Helsa, and Kenedi (2022) was written using quantitative research method with a positivism approach, this journal collects data in numbers or numerical data and analyzes it using parametric statistical techniques. Based on the analysis, it can be concluded that the level of knowledge of students in the Industrial Era 4.0 needs to be improved. This shows a critical need to spread information about Industrial Era 4.0 to the students. Lecturers have a crucial role in conveying this information to students, but in this study, the role of lecturers in socializing the Industrial Era 4.0 is still not yet optimal. In conclusion, the more intensive attention and efforts in socializing the Industrial Era 4.0 to students needs to be done with lecturers as the primary agent in conveying this information. With a better understanding, students can prepare themselves with relevant skills in this evolving era.

11th article that was written by Marta-Lazo, Meigs-Frau, and Osuna-Acedo (2019) used quantitative method using questionnaires to collect data as the primary approach. However, a qualitative content analysis was also conducted to complement the findings obtained from the quantitative analysis. Overall, this study shows that the collaborative learning model in sMOOCs can enhance the participation and pedagogical transformation of learners who are future e-teachers. The results also highlight the importance of relational factors in the context of online learning, which has rarely been studied before. Learners' age and field of work also impact their engagement and interaction in sMOOCs. Therefore, the design of collaborative tasks in e-learning environments must consider these factors. This research has important implications in designing training practices for future e-teachers by emphasizing the importance of empowering learners through collaborative learning models in achieving pedagogical transformation.

In 12th article by Greenhow, Lewin, and Willet (2021), an activity theory is discussed to analyze the tensions and contradictions in the education system, especially during the transition to distance learning due to the COVID-19 pandemic. The author used this theoretical framework to explain the emerging impacts and challenges in the role of schools, education policies, and home learning processes. The discussion in this paper included a background explanation of the importance of this topic and the context of the shift to distance learning. Next, the author

discussed the basic concepts in activity theory and the relationship between individual and collective activity in an educational context. The article makes several important points: 1. Tensions and contradictions: The author identified tensions and contradictions within and between systems during the transition to distance learning due to the COVID-19 pandemic. 2. Stakeholder experiences: The authors highlight the experiences and treatment of various stakeholders, such as teachers, parents, and policymakers towards digital pedagogy during distance learning. 3. Tensions in digital pedagogy: There are tensions between digital pedagogy approaches, system rules, and teachers' digital skills. The authors recognized that these aspects affect the effectiveness of distance learning. 4. Parental responsibility: Increased parental responsibility in distance learning created new tensions in the rapidly evolving school activity system. 5. Research recommendations: The discussion section highlighted the importance of in-depth exploratory research and large-scale studies to understand further and resolve the tensions identified in this study. Overall, the discussion underscores the need for a holistic understanding and a sustainable approach to addressing the challenges and tensions arising from the shift to distance learning due to the COVID-19 pandemic.

13th article was written by Vaataja and Ruokamo (2021) discussed activity theory as a method to analyze the tensions and contradictions in the education system, especially during the transition to distance learning due to the COVID-19 pandemic. The author used this theoretical framework to explain the emerging impacts and challenges in the role of schools, education policies, and home learning processes. The discussion in this paper included a background explanation of the importance of this topic and the context of the shift to distance learning. Next, the author discussed the basic concepts in activity theory and the relationship between individual and collective activity in an educational context. The article made several important points: 1. Tensions and contradictions: The author identified tensions and contradictions within and between systems during the transition to distance learning due to the COVID-19 pandemic. 2. Stakeholder experiences: The authors highlight the experiences and treatment of various stakeholders, such as teachers, parents, and policymakers towards digital pedagogy during distance learning. 3. Tensions in digital pedagogy: There are tensions between digital pedagogy approaches, system rules, and teachers' digital skills. The authors recognize that these aspects affect the effectiveness of distance learning. 4. Parental responsibility: Increased parental responsibility in distance learning creates new tensions in the rapidly evolving school activity system. 5. Research recommendations: The discussion section highlighted the importance of in-depth exploratory research and large-scale studies to understand further and resolve the tensions identified in this study. Overall, the discussion underscored the need for a holistic understanding and a sustainable approach in addressing the challenges and tensions arising from the shift to distance learning due to the COVID-19 pandemic.

In the 14th article by Leahy and Dolan (2010), a literature review method was used in research to collect, evaluate, and synthesize relevant literature in a particular field of knowledge or topic. The literature review aims to gain a comprehensive understanding of previously conducted research, identify knowledge gaps, and direct new research directions. People live in a rapidly changing world in both their business and personal lives. With the continued pace of technological change, as predicted by Gordon Moore in 1965 [1], What competencies are needed to take full advantage of today's Knowledge Society? The European Union has recognized the need for digital literacy and included it in its definition of e-Inclusion [2]. This paper defined digital literacy as a competency essential for all citizens, examined the changing definition of

digital literacy, looked at what certification bodies say, and proposed competencies that are needed and that define digital literacy today.

In 15th article by Lunevich (2021), as with any innovation, innovations in pedagogy, especially critical digital pedagogy, take new ideas and practices and bring them together in new ways to solve problems that currently lack adequate solutions. Developing new pedagogical models involves identifying problems, testing old practices, and suggesting new ones. This research evaluated different themes of critical pedagogy, suggested innovative models, and focused on intentions when evaluating pedagogies rather than assuming they all serve the same purpose. It suggested a critical digital pedagogy framework for teachers' many decisions to assess their teaching and their student's digital literacy.

16th article made in 2018, used literature review as the method. Teachers faced several challenges in implementing digital pedagogy, including a need for more time, resources, and support. 3. Effective learning design can help overcome these challenges by providing practical strategies for teachers to design engaging and effective digital learning experiences. 4. Activity theory provides a helpful lens for understanding the complex interactions between teachers, students, and technology in the classroom. 5. The ITEC project's digital toolkit for teachers is a valuable resource for supporting scenario-based learning design and developing digital pedagogy.

In article 17th article that was written by Puspitasari, Hanik, Safitri, Firdaus, Pratiwi, and Innayah (2022), the researcher applied a qualitative method in writing this report, namely the collection of data sources derived from virtual interviews and research journals, which prioritized the theme of Integrating the TPACK (Technological, Pedagogical, Content Knowledge) Approach to implementing education in the digital era. The digital era is currently also influential in the world of education. The characteristics of many students are close to technology and seen from the ability of the school to facilitate technology so that educators and schools integrate the TPACK (Technological, Pedagogical, Content knowledge) approach to implementing education in the digital era. This study aims to describe the integration of the TPACK (Technological, Pedagogical, Content knowledge) approach of SIKL Elementary School to implement digital era education. The method applied by researchers to this report is a qualitative method or method, namely the collection of data sources derived from virtual interviews and research journals which prioritize the theme of the Integration of the TPACK Approach (Technological, Pedagogical, Content knowledge) to carry out education in the digital era. This research showed that the TPACK (Technological, Pedagogical, Content Knowledge) Integration Approach is a learning framework for processing various forms of new learning that uses the combination of three essential components, including technology, pedagogic, and content/material knowledge, and consists of seven TPACK components, namely CK (Content Knowledge), PK (Pedagogy Knowledge), TK (Technology Knowledge), TPK (Technological Pedagogical Knowledge), TCK (Technological Content Knowledge), PCK (Pedagogical Content Knowledge) and TPACK (Technological Pedagogical Content Knowledge). In overcoming problems related to integrating the TPACK approach in the digital era during the covid-19 pandemic, Sekolah Indonesia Kuala Lumpur (SIKL) continues adopting blended learning by using google classroom as a learning platform.

The 18th article by Handayani, Riyani, and Kirana (2020) was written which talks about development research that adopts the ADDIE model. This research consisted of three stages. The first stage identified problems in microlearning, while the second stage analyzed the advantages and disadvantages of the learning method. The third stage aimed to develop teaching

materials that will be used in prototyping the new microteaching module. The data source for this research was obtained through various methods such as focus group discussions, observations, interviews, and questionnaires. In analyzing the data, this study used Miles and Huberman's qualitative data analysis method, which includes data display, data reduction, and verification. The results showed that microteaching, implemented in the even semester of the 2019/2020 academic year, faced problems due to the COVID-19 pandemic. Microteaching cannot be fully implemented according to the semester learning plan because it cannot be carried out in the microteaching laboratory room. Instead, learning is conducted at each student's location online. Undoubtedly, this will be challenging for students as it differs from the initial idea of the theory. At first, students can practice the theory of basic teaching skills with classmates, supervised by practitioners and lecturers, and get advice from peers. To overcome the problem, course lecturers must be creative to adapt to the situation experienced during the pandemic. In microteaching, lecturers used a happy learning strategy. Before students start teaching practice, they give students a virtual happy lecture. This allows students to practice in a pleasant psychological atmosphere.

Written by Rodés, Porta, Garófalo, and Enríquez (2021), the 19th article was conducted in order to help teachers transition to remote teaching in emergencies situations such as the COVID-19 pandemic, MOOC-based teacher professional development (TPD) methods have been proven effective. MOOCs allow teachers to access quality and up-to-date educational resources and facilitate interaction and collaboration between teachers. This method involves identifying teachers' needs, designing relevant courses, developing quality content, implementing courses through MOOC platforms, and evaluating and receiving feedback from course participants. It was also essential to apply a critical approach to digital pedagogy in TPD, which involves critical thinking about how educational technology can support learning and how teachers can design learning strategies that fit the digital learning environment. MOOC-based TPD methods provide an effective solution for acquiring the skills and knowledge required by teachers to teach remotely in emergencies circumstances such as the COVID-19 pandemic.

In writing the 20th article which discussed the digital pedagogy in the industrial era 4.0, Purfitasaria, Masrukhib, Prihatin, and Mulyono (2019) as the researchers used the literature review as the method. Overall, from the discussion it can be concluded that the industrial revolution 4.0 has increased the use of technology in various aspects of life, including education. There needs to be a greater understanding of the utilization of technology in learning. As an alternative, digital pedagogy emerges as a learning approach that utilizes technology to create learning opportunities that differ from traditional practices. In digital pedagogy, learners may choose learning methods that suit their needs and allow them to learn in various places. While there are challenges, such as a lack of teacher preparation and supportive infrastructure, there are also great opportunities to improve the quality of learning through technology. Essential concepts in digital pedagogy, such as blended learning, flipped classroom, and mobile learning, are also revealed, with the advantages and disadvantages of each concept.

In 21th article written by Putrawangsa and Hasanah (2018), the data source was analyzed using relevant literature (desk analysis). This study described the role and principles of digital technology integration in learning in the Industrial Age 4.0. The integration study is reviewed from the perspective of mathematics learning. It can be concluded that the basic principle in integrating digital technology in mathematics learning is that the use of technology does not lead to poor conceptual understanding or replace the role of students' intuition in mathematics. Instead, the technology aims to improve students' conceptual understanding and develop

students' intuition in mathematics. It was known that there are three didactic functions of digital technology in learning mathematics, namely: (1) Technology for doing mathematics, namely technology that functions as an alternative tool to replace learning media to carry out mathematical activities; (2) Technology for practicing skills, namely technology that functions as a learning environment to hone specific mathematical skills; (3) Technology for developing conceptual understanding, namely digital technology that functions as a learning environment to develop students' conceptual understanding of certain mathematical concepts. This third didactic function is most expected from integrating digital technology in mathematics learning.

Conducted by Sulistyarini and Sulistyarini (2022), the 22th article used quantitative methods with random sampling techniques. The data collection instrument used a Likert scale through a teacher filled out a questionnaire that has been provided; then, the researcher analyzed the questionnaire. The subjects in this study were teachers at SMPN 2 Nusawungu, Cilacap, with a total sample of 31 correspondents. The results showed that the understanding of teachers' digital literacy and the utilization of learning media had a positive and significant effect simultaneously on the pedagogical competence of teachers in the digital learning era at SMP Negeri 2 Nusawungu. This shows that digital literacy and the use of learning media can help improve teachers' pedagogical competence in the digital era. It can be concluded that the understanding of teacher digital literacy partially has a positive and significant effect on teachers' pedagogical competence in the digital learning era at SMP Negeri 2 Nusawungu. This shows that the skills in the digital learning era needed for teachers to understand digital literacy. These skills will improve teachers' pedagogical competence so that teachers can increase their insight and manage learning well. In addition, teachers' digital literacy understanding and learning media utilization have a significant and positive influence on teachers' pedagogical competence.

In the 23th article by Fredlina and Dewi (2022), the researcher added a discussion about the method of implementing community service activities. The method is explained in several stages based on the priority of the problems faced by the partners. This means that the steps in implementing community service activities are systematically arranged based on the level of importance of the problems faced by the partners. In the document, the author concluded that the service activities have been carried out well and have positively contributed to helping teachers at SMA Negeri 1 Petang create a more exciting learning process. The researcher mentioned that the service activity was carried out well indicates that the objectives and expected results of the activity have been achieved.

Finally, in the 24th article by Purnasari and Sadewo (2021) was written using a qualitative research method with a case study approach was used in this research. The research subjects consisted of four elementary schools in Bengkulu Regency, namely SDN 2 Sungai Betung (accredited A), SDN 2 Bengkulu (accredited B), SDN 12 Sengkabang (accredited C), and SDN 11 Kelampe (not accredited). The data were collected through interviews, observations, questionnaires, and data triangulation techniques to ensure the data's validity or credibility. In the results and discussion on the mentioned page, it was found that education in the Bengkulu region faces several challenges that cause it to lag behind compared to urban areas. The discussion identified two main internal factors that affect the learning process: the low quality of human resources (HR) and the lack of school facilities and infrastructure. This may affect the quality of teaching and mentoring students, so the learning process needs to reach its full potential. In addition, the lack of school facilities and infrastructure includes the need for physical facilities, libraries, laboratories, and other facilities that are important in supporting interactive and comprehensive learning. In addition to internal factors, the discussion also

revealed the existence of external constraints that affect learning in the region—some schools in Bengkayang face accessibility difficulties, which can limit student participation and hinder the learning process. Furthermore, some schools do not have access to electricity, which negatively affects the use of technology and facilities that require an electricity supply. The findings of the problems and their solutions are as follows; 1. Low quality of human resources; -Solution: Improving the quality of human resources through training and professional development of teachers and educators. 2. Lack of school facilities and infrastructure: -Solution: Improving physical facilities and supporting facilities in schools, including infrastructure, libraries, laboratories, sports facilities and educational technology. 3. Difficult accessibility of schools: -Solution: Provision of adequate transportation and improvement of road infrastructure to enhance school accessibility. 4. Unavailability of electricity supply: -Solution: Provide a stable electricity supply through cooperation with related agencies and stakeholders. 5. Learning process is not maximized: -Solution: Improving learning methods and strategies with an active, creative approach and using educational technology. By implementing these solutions, it is expected that education in the Bengkayang region can overcome internal and external problems and improve the quality of learning to be more optimal and equal to urban areas.

#### D. Conclusion

In today's digital era, pedagogics and technology are two things that cannot be separated in the world of education. Pedagogical ability is a concept that is very relevant in integrating technology into the learning process. The application of technology in the learning process also has challenges and risks. Therefore, continuous efforts to improve the quality of digital learning and overcome the challenges that arise are needed. In addition, the role of educators and education managers is crucial in ensuring the application of pedagogic skills in the era of technological digitalization in learning. Implementing TPACK also faces challenges, such as limited access to technology and educators' need for more readiness to use technology in learning. Therefore, efforts are needed to overcome these challenges, such as training for educators and efforts to expand access to technology. Thus, implementing the TPACK model in learning in the digital era can help improve the quality of education in Indonesia

#### References

- Adlina, N. (2022). Inovasi pembelajaran di masa pandemi covid-19 dengan pendekatan steam di era society 5.0. *Jurnal Ilmu Sosial dan Pendidikan*, 2(6), 619-627
- Afshari, M., Bakar, K. A., Luan, W. S., Samah, B. A., & Fooi, F. S. (2009). Factors affecting teachers' use of information and communication technology. *International Journal of Instruction*, 2(1).
- Anita, Y., Arwin, A., Ahmad, S., Helsa, Y., & Kenedi, A. K. (2022). Pelatihan Pengembangan Bahan Ajar Digital Berbasis HOTS Sebagai Bentuk Pembelajaran Di Era Revolusi Industri 4.0 Untuk Guru Sekolah Dasar. *Dedication: Jurnal Pengabdian Masyarakat*, 6(1), 59-68.
- Febriani, SR, & Mahmudi, A. (2021). Implementasi Pembelajaran Kooperatif Dan Mandiri Pada Keterampilan Menulis Di Era Revolusi Industri 4.0. *Jurnal Al Mi'yar* 4 (1).
- Frankena, W. K. (2010). *The concept of education today*. In *Educational judgments* (pp. 14–24). Routledge.
- Fredlina, K. Q., & Dewi, P. A. C. (2022). Digitalisasi Konten Pembelajaran di SMA Negeri 1 Petang, Bali. *JIIP-Jurnal Ilmiah Ilmu Pendidikan*, 5(8), 2762-2766.

- Greenhow, C., Lewin, C., & Staudt Willet, K. B. (2021). The educational response to Covid-19 across two countries: A critical examination of initial digital pedagogy adoption. *Technology, Pedagogy and Education*, 30(1), 7-25.
- Handayani, S., Riyani, R., & Kirana, K. (2021). Pendekatan Joyful Learning dalam Pembelajaran Microteaching di Era Revolusi Industri 4.0. *Research Fair Unisri*, 5(1), 121-128.
- Kurnianingsih, I., Rosini, R., & Ismayati, N. (2017). Upaya peningkatan kemampuan literasi digital bagi tenaga perpustakaan sekolah dan guru di wilayah Jakarta pusat melalui pelatihan literasi informasi. *Jurnal Pengabdian Kepada Masyarakat*, 3(1), 61-76
- Leahy, D., & Dolan, D. (2010). Digital literacy: A vital competence for 2010?. In Key Competencies in the Knowledge Society: IFIP TC 3 International Conference, KCKS 2010, Held as Part of WCC 2010, Brisbane, Australia, September 20-23, 2010. Proceedings (pp. 210-221). Springer Berlin Heidelberg.
- Lewin, C., Cranmer, S., & McNicol, S. (2018). Developing digital pedagogy through learning design: An activity theory perspective. *British Journal of Educational Technology*, 49(6), 1131-1144
- Lunevich, L. (2021). Critical Digital Pedagogy and Innovative Model, Revisiting Plato and Kant: An Environmental Approach to Teaching in the Digital Era. *Creative Education*, 12(9), 2011-2024.
- Marta-Lazo, C., Frau-Meigs, D., & Osuna-Acedo, S. (2019). A collaborative digital pedagogy experience in the tMOOC "Step by Step". *Australasian Journal of Educational Technology*, 35(5), 111-127.
- Purfitasari, S., Masrukhi, M., Prihatin, T., & Mulyono, S. E. (2019). Digital Pedagogy sebagai Pendekatan Pembelajaran di Era Industri 4.0. In *Prosiding Seminar Nasional Pascasarjana (PROSNAMPAS)* (Vol. 2, No. 1, pp. 806-811).
- Purnasari, P. D., & Sadewo, Y. D. (2020). Pemanfaatan teknologi dalam pembelajaran sebagai upaya peningkatan kompetensi pedagogik. *Publikasi Pendidikan*, 10(3), 189-196
- Puspitasari, D., Hanik, E. U., Innayah, R. N., Firdaus, H. R., Safitri, E., & Pratiwi, M. (2022). Integrasi Pendekatan Dalam Melaksanakan Pembelajaran Era Digital di Sekolah Indonesia Kuala Lumpur (SKIL). *Basica: Journal of Primary Education*, 2(1), 54-66.
- Putrawangsa, S., & Hasanah, U. (2018). Integrasi teknologi digital dalam pembelajaran di era industri 4.0: Kajian dari Perspektif Pembelajaran Matematika. *Jurnal Tatsqif*, 16(1), 42-54.
- Rahayuningsih, Y. S., & Muhtar, T. (2022). Pedagogik Digital Sebagai Upaya untuk Meningkatkan Kompetensi Guru Abad 21. *Jurnal Basicedu*, 6(4), 6960-6966
- Rochaendi, E., Wahyudi, A., & Perdana, R. (2021). Kompetensi Teknologi, Pedagogi, dan Konten Guru SD Negeri dan Swasta di Kota Cimahi, Jawa Barat. *JPDI: Jurnal Pendidikan Dasar Indonesia*, 6(1), 1-7.
- Sulistyarini, W., & Fatonah, S. (2022). Pengaruh Pemahaman Literasi Digital dan Pemanfaatan Media Pembelajaran Terhadap Kompetensi Pedagogik Guru Era Digital Learning. *Journal of Educational Learning and Innovation (ELIA)*, 2(1), 42-72
- Tampubolon, K., Elazhari, E., & Batu, F. L. (2021). Analisis dan Penerapan Tiga Elemen Sistem Pembelajaran pada Era Industri 4.0 di Universitas Pembinaan Masyarakat Indonesia. *All Fields of Science Journal Liaison Academia and Society*, 1(2), 153-163.
- Tari, E., & Hutapea, R. H. (2020). Peran guru dalam pengembangan peserta didik di era Digital. *Kharisma: Jurnal Ilmiah Teologi*, 1(1), 1-13
- Ting, Y.-L. (2015). Tapping into students' digital literacy and designing negotiated learning to promote learner autonomy. *The Internet and Higher Education*, 26, 25-32.

- Väätäjä, J. O., & Ruokamo, H. (2021). Conceptualizing dimensions and a model for digital pedagogy. *Journal of Pacific Rim Psychology*, 15, 1834490921995395
- Windarto, W. (2021). Kode Etik Guru Dalam Pengaplikasian Media Pembelajaran Online Pai Di Era Revolusi Industri 4.0. *Al Qalam: Jurnal Ilmiah Keagamaan dan Kemasyarakatan*, 15(1), 15-27.
- Zabidi, A. (2019). Kreativitas guru dalam memanfaatkan teknologi sebagai media pembelajaran pai di SD Sekecamatan Bawen Kabupaten Semarang. *Jurnal Inspirasi*, 3(2)