



Pedagogic Competence in Primary School: Digital Didactical Design to Develop Teacher's Performance

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Abstract. Classroom teachers must engage in creative problem-solving and pedagogical reform To adapt to the digital age. To equip their pupils for the challenges of the twenty-first century, educators must master the art of creating personalized learning programs. This research looks at how primary school educators who participate in Digital Didactical Design (3D) gain new perspectives on the design and usage of digital technologies in their science lessons. The subject under investigation concerns the enhancement of elementary school educators' familiarity with digital tools through the usage of 3D. This article employs a systematic literature review strategy, drawing on reviews of related material from a wide range of publications (books, journals, etc.). The findings suggest that 3D has the potential to enhance meaningful learning experiences using a framework that invites educators to participate in the design process and then investigate, explore, and analyze the designs as they are implemented in the classroom. In addition, elementary school educators can use this study as a reference for planning lessons tailored to their children's specific requirements. The more detailed the strategy, the better the results will be regarding knowledge acquisition. Instructors need to engage in this activity to improve their skills as educators.

Keywords: digital didactical design · pedagogic competence · primary school · teacher's performance

1 Introduction

The rate of new knowledge is increasing too fast for people to process it all [1]. Integrating digital solutions into regular life necessitates a digital transformation [2]. That has repercussions in many fields, including economics, manufacturing, and medicine. Digital change can enhance and inspire novel answers to old problems [3]. This paradigm shift caused by the rapid adoption of technology affected all sectors, including education [4]. The entire educational infrastructure has gone digital. Even the method of collecting information in classrooms has become computerized. The data we collect about schools,

educators, and students is readily available. In addition, changes in technology affect education. To meet the needs of their students, today's educators must be technologically literate [5]. Competency in the digital age is a necessity for today's educators.

The teacher is ready to provide learning to students when the teacher masters technology, so mastery of technology is very important for a teacher to have [6]. Although in its implementation, the teacher will encounter various challenges. Teachers must be ready to accept all risks and continue to behave professionally [7]. When facing the challenges of the 21st century, teachers must be able to improve their competence and continue to dig up as much information as possible [8]. Teachers are expected to always be up to date and not outdated. Because the teacher is one of the agents of change, the teacher must make changes from within himself. Then the teacher can give it to the students, so they have a proper provision of science and technology. Not only that, but teachers must also equip students with character and personality education. Science and technology alone are not enough to face the challenges of today's 21st-century learning [9, 10]. Therefore, teachers must have a lot of knowledge, think critically, be ready to face all kinds of challenges, and be wise in dealing with problems [4].

However, there is an inequality in the form of a gap between hope and reality, namely the demands of digitalization for teachers on the abilities of teachers themselves [11]. Conditions in the field are still very poor in terms of quality, professionalism, and quantity [12]. The students facing teachers today are students born in the digital age [13]. They are used to things related to the internet and have often played with smartphones. Especially with a large number of social media and games that have now penetrated all circles, making students proficient by themselves in using technology. However, some teachers have not been able to use technology and information properly and wisely [14, 15]. For example, some teachers are less proficient in using computer devices or smartphones. That is caused by various factors, one of which is the lack of facilities and infrastructure so that teachers are not used to using smartphones.

A review of several journal studies shows that teachers in Indonesia have difficulty monitoring learning using technology. The World Bank estimates that only 5% of primary school teachers in Indonesia have teaching skills using digital media that are good enough to improve their student learning [16]. The teacher-based teaching approach is dominant compared to the student-centered approach, with little meaningful student interaction when online learning [17]. In addition, teacher development programs are generally of low quality and do not result in improved teaching practices [18].

However, some teachers can already use computer devices but are not proficient in using various learning applications [19]. Of course, the teacher needs to expand his knowledge again, such as often attending training on digital teaching media or participating in various webinar activities organized by the Ministry of Education and Culture. Information and Computer Technology (ICT) training can improve teachers' pedagogical competence in teaching using ICT devices [20].

The development of information technology media is one of the main foundations in the development of the 21st century [21, 22]. Information media is a mandatory thing used in everyday life, one of which is the use of the internet. However, when information comes very quickly, it is not uncommon for news on the internet to be duplicated and replicated very unnaturally. Much of the information received by the public is not valid in

truth, so the public is consumed by fake news [23]. Of course, this may happen to teachers. Teachers must improve their digital literacy to ensure the information received today is true [24]. Likewise, students experience, because there is more and more information, students have difficulty getting good news or according to their needs [25]. The more information received, the easier it is for them to get carried away or even get lost in the virtual world [26]. In this case, a teacher has an important role in facing various challenges that will occur in the future related to technology and information [27].

The development of increasingly advanced technology has also brought changes in the context of pedagogy, namely changes that encourage the birth of technology-based teaching [28]. This condition encourages teachers to be sensitive to the development of the times and develop and improve their pedagogic competencies [29]. Pedagogic competence is the ability of teachers to manage to learn. One of the scopes of this competence is the absolute mastery of teachers' models, methods, strategies, and learning techniques and establishing them in the teaching and learning process. Teachers who have pedagogical competence are expected to be able to design or design effective and efficient learning [30].

Teachers must choose the right learning model to create effective, efficient, and interesting learning. It is said to be effective if the learning design has a positive impact on improving student learning outcomes, being able to solve problems, and answering needs related to teaching and learning [13]. Furthermore, efficient learning is illustrated in the implementation of completed learning by the planned time allocation. At least three tasks must be carried out by teachers related to pedagogic competence, including planning learning, implementing learning plans, and evaluating learning [31]. The learning process is the most important part that teachers must carry out in schools. A student's success in understanding the context of the material being taught depends on how well the learning process can be carried out properly. The learning process involves various activities between the student, the teacher, and the learning environment, which is then controlled in the learning plan. The more mature the teacher plans the lesson plan, the better the learning process. Teaching without writing preparation will result in ineffective learning. That is based on the fact that the teacher does not think in detail about what will be done and how to do it [32].

In this way, the teacher needs to develop a learning plan that views the learning situation as a whole and real object. The thing that must be of concern to the teacher in making a lesson plan is how to look at the various possible responses of students, both didactic and pedagogical, to be anticipated in such a way [33]. The learning process can create dynamics of didactic and pedagogical changes according to the capacities, needs, and acceleration of the learning process experienced by students, especially if you look at the stage of thinking development of elementary school students who are still in the concrete operational stage. The learning process must be realistic, following the real conditions experienced by students [34].

However, many educators still lack the necessary pedagogical ability. There is still a constant need to develop and refine the abilities of educators to manage student learning, particularly in the areas of technology fluency and integration. Among elementary schools in East Kalimantan, researchers found that teachers' comprehension of learning technology was still poor, making it difficult to use technology to enhance the teaching

and learning process. While on the job, many educators fail to update and expand their expertise. To reinvigorate the educational process, educators must maintain cutting-edge scientific and technological literacy [35]. Unfortunately, many classroom instructors continue to use antiquated methods of instruction. As a result, educators must be provided with opportunities for ongoing professional development, including but not limited to courses, seminars, workshops, and technical advice and direction.

Teachers can no longer underestimate the importance of mastering technology. Until 2019, teachers can still make school learning patterns offline or offline. However, in early 2020 with the Covid-19 outbreak, the government encouraged switching teaching systems and strategies where teachers must master technology and carry out technology-based learning (Day et al., 2021). That can be a challenge for teachers in the digital age to understand the unique characteristics of students as a digital generation [36]. Teachers must be able to align learning objectives with student development in this digital era. The application of technology in learning also cannot be ignored, considering that students today are the digital generation.

Furthermore, the development of ICT (Information and Communication Technology) can now be a great opportunity for teachers to improve good relations with parents so that there can be harmony between education at school and at home. ICT in learning has a role, namely helping to package teaching materials [37]. That is intended so that the learning process can run more effectively. The use of technology in learning can be realized by developing electronic-based learning media, utilizing social media in teaching and learning activities, developing learning strategies, and combining online and offline learning (blended learning).

In reality, the online learning system has not been able to be implemented evenly in Indonesia. That is because there are still many areas in Indonesia that are classified as isolated areas. This condition shows a considerable inequality between urban and rural areas in Indonesia regarding using technology to support learning. Similar problems are also experienced by teachers in elementary schools where online learning triggers many obstacles and causes new problems. That encourages teachers to open themselves to using technology in learning because the solution to online learning is to use technology in teaching and learning activities. The study examines the Digital Didactical Design (3D) paradigm in developing teacher pedagogical competencies.

2 Methodology of Research

This article employs the strategy of a systematic literature review. A systematic literature review is a method of research that seeks to provide a basis for resolving existing problems by systematically identifying, analyzing, evaluating, and drawing conclusions about the overall results of research on the topic at hand [38]. This research relies on secondary sources for its data. Collecting secondary data does not necessitate original fieldwork [39]. The goal is to study and compile data from the library's shelves. Literature is chosen based on the following criteria: (1) it must be directly related to Digital Didactical Design (3D) and academic competence; (2) it must be drawn from research reports, national journals, international journals, relevant books, scientific articles, and scientific data about the study of this article; (3) it must have been published within the last ten years (2013–2022).

Systematic literature reviews consist of the following phases: (a) planning, wherein researchers must formulate the steps to be carried out and determine the research question; (b) review, wherein researchers select and categorize literature, screen and determine relevant literature, and draw conclusions to the entire literature set; and (c) reporting [40]. These results are used in the investigation of the targeted topics. Articles, journals, proceedings, and conference papers that have already been published are the only ones considered. This inquiry was formulated by the researcher to test the practicability of the chosen literature. The following inclusion/exclusion criteria are used to generate the questions:

- a) QA1: Is there access to the full texts of papers presented at conferences and published in journals?
- b) QA2: Were articles utilized as references from the recent decade (2013–2022)?
- c) QA3: Does the current literature explore and analyze the relationship between pedagogical competency and Digital Didactical Design (3D)?
- d) QA4: Is the literature presented in English?

3 Results of Research

In the preliminary stages of the search, 24.773 articles were found that did not meet the inclusion criteria. In addition, the literature was collected after being subjected to many filters in order to select just the most pertinent material. A total of 26 articles were found to be relevant to the issue after searching Google Scholar, Scopus, and SAGE Journals (Fig. 1).

The 21 different types of literature were selected according to the following criteria: (1) journals and conferences that publish full papers; (2) a minimum publication limit of the last ten years (2013–2022); (3) papers that address 3D and pedagogical competence; and (4) papers presented in English. Table 1 displays the outcomes of the quality evaluation.

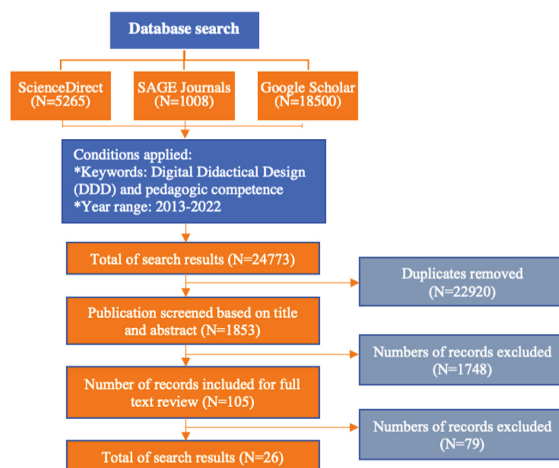


Fig. 1. Flow of information through the different phases of a systematic literature review

Table 1. List of Reviewed Articles

No.	Article's Code	Year	Quality Assessment				The Results
			QA1	QA2	QA3	QA4	
1	Article 1 [41]	2021	Yes	Yes	Yes	Yes	Accepted
2	Article 2 [42]	2020	Yes	Yes	Yes	Yes	Accepted
3	Article 3 [43]	2021	Yes	Yes	Yes	Yes	Accepted
4	Article 4 [44]	2020	Yes	Yes	Yes	Yes	Accepted
5	Article 5 [45]	2014	Yes	Yes	Yes	Yes	Accepted
6	Article 6 [46]	2015	Yes	Yes	Yes	Yes	Accepted
7	Article 7 [47]	2017	Yes	Yes	Yes	Yes	Accepted
8	Article 8 [48]	2014	Yes	Yes	Yes	Yes	Accepted
9	Article 9 [49]	2014	Yes	Yes	Yes	Yes	Accepted
10	Article 10 [50]	2017	Yes	Yes	Yes	Yes	Accepted
11	Article 11 [51]	2020	Yes	Yes	Yes	Yes	Accepted
12	Article 12 [52]	2020	Yes	Yes	Yes	Yes	Accepted
13	Article 13 [53]	2018	Yes	Yes	Yes	Yes	Accepted
14	Article 14 [54]	2022	Yes	Yes	Yes	Yes	Accepted
15	Article 15 [13]	2021	Yes	Yes	Yes	Yes	Accepted
16	Article 16 [55]	2017	Yes	Yes	Yes	Yes	Accepted
17	Article 17 [56]	2019	Yes	Yes	Yes	Yes	Accepted
18	Article 18 [57]	2019	Yes	Yes	Yes	Yes	Accepted
19	Article 19 [58]	2019	Yes	Yes	Yes	Yes	Accepted
20	Article 20 [59]	2017	Yes	Yes	Yes	Yes	Accepted
21	Article 21 [60]	2020	Yes	Yes	Yes	Yes	Accepted
22	Article 22 [61]	2019	Yes	Yes	Yes	Yes	Accepted
23	Article 23 [62]	2015	Yes	Yes	Yes	Yes	Accepted
24	Article 24 [63]	2020	Yes	Yes	Yes	Yes	Accepted

Information:

1. Yes (Y) for the type of material that was consulted and was appropriate to the study. In-depth discussions and analyses of digital change, pandemic pedagogy, online learning, and a wealth of information all contributed to the data's selection as the study's major source.
2. The second category, "Literature that isn't used in research because it doesn't relate to the topic being studied and isn't good enough in terms of the information it gives," is labelled with a "T," meaning "not used."

4 Discussion

4.1 The Role of Teachers in Creating Learning Planning

The philosophy underlying didactic design is understanding the forms of educational innovation and the efforts of researchers in creating educational innovations [48]. The learning process generally learns about the phenomena of learning and teaching that occur between teachers, students, and materials/knowledge. Activity in the learning process is depicted in the following triangle (Fig. 2).

Teachers play an important role in the implementation of learning. In a didactic triangle, the teacher is not only required to master the material related to the context of the knowledge to be taught but must understand the real conditions of the students [46]. In addition, the teacher must create a didactic-pedagogical situation to encourage students to learn optimally. In this part, the role of the teacher is to allow didactic transpositions, including transforming knowledge that comes from the world of research into knowledge that teachers must compile in learning planning until the knowledge is taught to students [50].

Two relationships occur in didactic situations, including the relationship between the teacher and the learning material. The material is one of the content contained in learning planning. The teacher should understand the material/ knowledge taught to students. That is a benchmark for students in understanding the material to be taught.

4.2 Learning Planning Using Digital Didactical Design

Digital Didactical Design (3D) is a breakthrough as a learning innovation, especially towards guidelines in compiling complete learning; essential things related to the learning process are contained in lesson design [55]. Digital didactical design in the development of teaching materials goes through three stages: (a) Analysis of the didactic

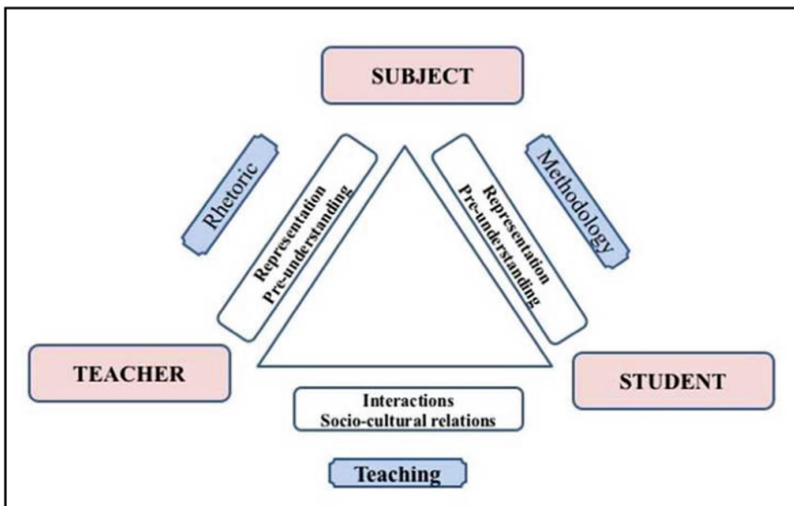


Fig. 2. The didactic triangle with its three axes and aspects

situation carried out by the teacher before learning, in the form of teacher thoughts about predictions and anticipation of student responses that will arise at the time of learning. (b) Didactic metapeda analysis was carried out during the learning process in the form of the teacher’s ability related to learning events to view the components of a modified didactic triangle [51]. Then, the teacher develops actions to create a didactic and pedagogical situation that suits the needs of the students, identifies and analyzes student responses as a result of didactic and pedagogical actions carried out, and performs advanced didactic and pedagogical actions based on the results of the analysis of student responses towards the achievement of learning targets. (c) Retrospective analysis, which is an analysis that relates the results of the analysis of the hypothetical didactic situation with the results of metapedadictic analysis in the form of post-learning reflections. Digital didactical design is one way to develop teachers’ pedagogical competence in elementary schools [48].

Some simple steps that must be prepared by the teacher in making lesson design are as follows: (a) Analyzing various knowledge about the material to be learned, (b) Compiling a learning syllabus to be developed related to the basic competencies to be taught, (c) Compiling learning objectives and learning instruments, (d) Compiling student learning flows, (e) Making a set of teaching materials and student learning assignments, (f) Make various predictions of student responses that arise during learning, (g) Anticipate various predictions of student responses that arise, and (h) Develop digital didactic designs (Fig. 3). The steps are explained in the image below:

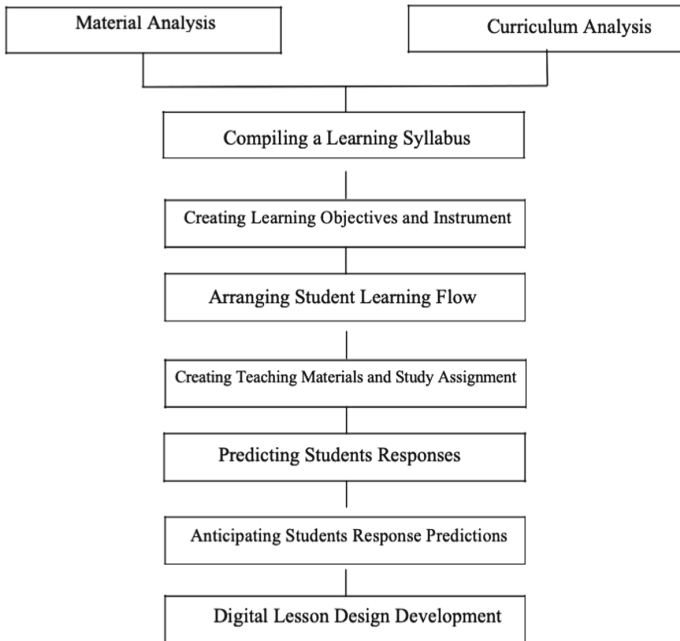


Fig. 3. Flow in making lesson design/learning planning

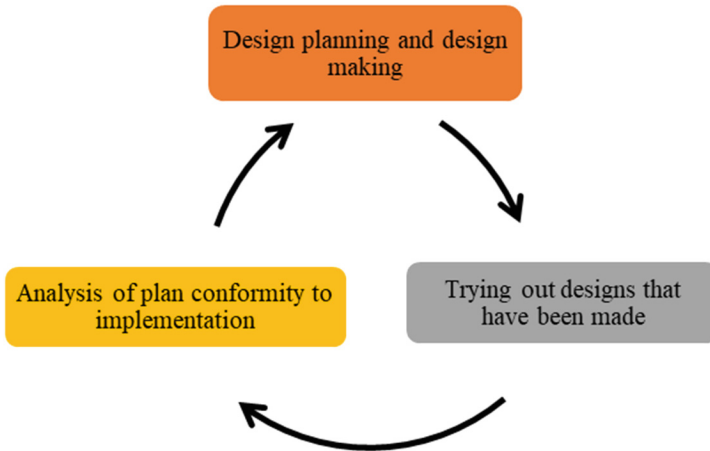


Fig. 4. Flow in Making Revision of Lesson Plans

The planning produced above is still hypothetical and must continue to be refined. Teachers can apply the results of the design that has been made and analyze the suitability of the responses that arise with the implementation of learning planning [55]. That is so that teachers can perfect the learning plan to revise the design that has been applied (Fig. 4).

By following the flow in the picture above, teachers can make learning plans by the conditions and needs of students so that the resulting learning will be meaningful (meaningful learning).

4.3 The Position Digital Didactical Design to Develop Pedagogic Competence

Education in the digital age emphasizes broader interaction, especially through information and communication technologies. The involvement of this technology allows the use of video tutorials, games on the internet, online quizzes, and various forms of interaction through cyber networks. It is important to define the pedagogical challenges of such technological involvement [58]. The first step teachers can take to examine what is needed for learning is by reviewing the learning theory that has existed so far to build a pedagogical framework that can answer the existing challenges. The collaboration between pedagogy and technology means developing conventional pedagogy to increase the involvement and activeness of previously limited students [52]. For example, students can now take over the role through digital learning resources if previously the teacher ended the learning and provided a summary of the material. They can contribute actively by summarizing and attaching links from digital sources, adding to the rich references [64].

Technology development is constantly changing priorities about what needs to be studied. For example, some new literacy is now very important such as making videos, animations, and websites. Memorizing knowledge is no longer important because the website presents all sorts of information [60]. Priorities shift to cultivating the ability

to find information, know when that information is needed, and evaluate the information found. Some aspects of change due to the industrial revolution 4.0 by taking the case in the United States: The state is getting farther and farther away from responsibility for children's education. Meanwhile, for adolescents and adults, education is the responsibility of each individual. Content focuses more on generic skills, such as problem solving and communication in various media, resource discovery, and how to study those resources. Pedagogy is developing towards dependence on interaction [53].

Sometimes such interactions involve technologies such as video tutorials, games on the internet, or interaction with other people through a computer network. Assessments are conducted after students have made progress through a computer-based learning environment to measure their success in achieving learning goals [43]. The learning location is no longer just centralized in schools but includes various places such as homes, offices, and learning centers, where students can access learning materials via the web. A culture with peers may weaken, and children struggle to do their tasks with parents and peers or even be isolated from others in the computer network. A shift in relationship patterns in learning is already happening. If students learned from adults in the past, nowadays, students learn from various parties/sources through computer networks. They are faced with a system that is responsive to what they do but lacks an understanding of individual students [65].

Some of the above changes in the field of education are relevant for most societies in different parts of the world today. The paradigm shift in managing education is the focus of various parties. Conventional pedagogy needs to be adjusted to align with the dynamics that occur [56]. The education considered appropriate is internet-based education and the digital world accompanied by character education. Education is not only about developing students' thinking potential but also about forming attitudes, behaviors, and personalities [61]. The use of digital media affects education characterized by digitization and computerization in the early stages, that is, students who have been using digital technology from an early age. Thus, the thinking paradigm and personality of learners are also influenced by changes due to industry 4.0 [56].

Finding a single, effective approach to education that works across disciplines, demographics, and learning goals is a never-ending quest, and the debate about technology in the classroom is illustrative of this [66]. Along with this comes the idea that the newest interactive media will be the "silver bullet" to end all of education's woes. Learning, one must concede, takes many forms, both among individuals and daily. That focus may then move to creating instructional media as an optional replacement for traditional classroom instruction. There is always an outpouring of novel approaches to education when new tools become available [13]. Finding the optimal strategy requires first comprehending the requirements of both students and educators.

In a perfect world, teachers would choose to use technology in the classroom because they genuinely care about its impact on their student's education. For instance, learners can select their unique learning route thanks to digitally designed curricula that allow for such customization. Learning strategies for groups where members work together to build their understanding of a topic [62]. Educators can also gather data bolstering analytical learning through digital pedagogical design [42].

Technology allows students and teachers to network with professionals in other fields, expanding the reach of learning communities [51]. Teachers can help students learn more effectively by utilizing simulation and gamification. In addition, it can offer insightful commentary on development. Technology can provide suggestions for future studies. Through a social networking system, kids can get help from their peers with the help of technology. That exemplifies the myriad practical benefits teachers may reap from using technology in their courses.

The International Society for Technology in Education (ISTE) identifies seven core competencies for students to succeed in today's interconnected digital world. (1) students who are given the tools to become proficient in the use of technology so that they can take an active role in setting their own learning goals, achieving those goals, and demonstrating their competence; (2) students who are responsible, law-abiding, and ethical users of digital technologies in their personal and professional lives. Innovative design that employs multiple technologies in the design process to identify and solve problems in novel, useful, or imaginative ways; computational strategies capable of developing and using strategies to understand and solve problems by harnessing the power of computers; and (3) building critical knowledge, in which students curate various digital resources to build knowledge, generate creative artifacts, and create meaningful learning experiences for themselves and others [62].

The philosophy of digital didactical design can form the basis for using technology in education [47]. Digital didactical design refers to actively participating in and reflecting on digitally-facilitated educational activities. Specifically, the digital didactical design (a) aims to improve critical understanding of the digital environment, (b) aims to foster creativity, play, and problem-solving, (c) encourages public participation, collaboration, and engagement, and (d) unites theory and practice, making, and thinking [44]. The digital didactical design focuses on how teachers may facilitate students' growth in cognitive and emotional domains through the strategic use of digital tools. Students observe and recreate the world around them using technology and student-centered learning to create a stimulating, inquisitive learning environment. So it's not just information being built but also critical thinking, inquisitiveness, empathy, and a desire to find workable answers to real-world problems [48].

Some axiomatic shifts from traditional pedagogy may be found in the digital didactical design, which shares more in common with the constructivist approach [45]. The digital pedagogical framework also incorporates lessons on using digital tools in the classroom. Digital pedagogical layouts should prioritize the collaborative construction of knowledge [63]. Planning for less content-heavy learning than problem-solving-based is incorporated into the digital didactical design. Taking this tack can make it seem like information is an obstacle rather than a benefit. Higher-order thinking can be encouraged, and pupils can go from rote memorization to conceptual understanding [54].

As an in-service project, designing digital technologies is a great way for elementary school teachers to expand their tech savvy [46]. Participation by educators in the design of digital technologies that address their own and their students' learning goals has been shown to increase their familiarity with and enthusiasm for incorporating such tools into classroom instruction [63]. The development and implementation of high-quality digital technologies to support instructors' competency and students' learning can benefit from

teachers' participation in participatory design. Students can learn analytical thinking, metacognition, and reflection by creating, revising, and distributing their work online [57].

Web 2.0 tools for social networking, including blogs, wikis, iPhones, and iPads, may also be included in digital pedagogy. In this sense, using technology in educational settings promotes global citizenship [41]. To effectively use technology in the classroom, educators must have the knowledge and experience to create new tools and assess their effectiveness. Several studies have looked into how teachers use digital pedagogy to teach literacy in the classroom. For instance, Bergström and Mrell-Olsson found that using an approach based on language experience, such as digital storytelling using PowerPoint presentations narrated by the author, increased reading motivation among students [62].

5 Conclusion

The shift in perspectives and ways of life in the digital age has also shifted the importance of learning through education and how to approach it effectively. Integrating technology into education is an urgent matter that needs to be implemented properly. That needs to be done to answer the need for education by the ongoing technological disruption. Digitalization in various sectors places today's young generation as digital learners who need different learning approaches to meet their expectations and needs in seizing opportunities and facing challenges in the future.

Teachers must carry out innovation and reform of learning. In facing the challenges of the 21st century, teachers must find the right formula to apply to students; this formula has to do with how students acquire knowledge in the learning process. Developing a lesson plan using digital didactical design (3D) is a new formula so that students get the knowledge they need because student success in the learning process is inseparable from the role of the teacher in preparing the lesson plan. In addition to the teacher as a learning facilitator, the teacher also acts as a learning architect in charge of compiling a lesson plan. The more detailed the plan is made, the success of learning will be achieved. This is what teachers need to do to improve their skills in the field of digital pedagogies in the context of digital didactical design. The goal is to create a generation of young people who are critical, adaptable, and socially intelligent so they can meet the needs of the industrial era. 4.0.

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References

1. C. Donohue and R. Schomburg, "Technology and interactive media in early childhood programs: What we've learned from five years of research, policy, and practice," *YC Young Child.*, vol. 72, no. 4, pp. 72–78, 2017.

2. A. A. Bilyalova, D. A. Salimova, and T. I. Zelenina, "Digital transformation in education," in *International Conference on Integrated Science*, 2019, pp. 265–276.
3. P. Soto-Acosta, "COVID-19 pandemic: Shifting digital transformation to a high-speed gear," *Inf. Syst. Manag.*, vol. 37, no. 4, pp. 260–266, 2020.
4. J. L. Plass and U. Kaplan, "Emotional design in digital media for learning," in *Emotions, technology, design, and learning*, Elsevier, 2016, pp. 131–161.
5. S. Saide and M. L. Sheng, "Knowledge exploration–exploitation and information technology: crisis management of teaching–learning scenario in the COVID-19 outbreak," *Technol. Anal. Strateg. Manag.*, vol. 33, no. 8, pp. 927–942, 2021.
6. H. Beetham and R. Sharpe, *Rethinking pedagogy for a digital age: Designing for 21st century learning*. routledge, 2013.
7. J. P. Gee, *The anti-education era: Creating smarter students through digital learning*. St. Martin's Press, 2013.
8. J. Voogt, O. Erstad, C. Dede, and P. Mishra, "Challenges to learning and schooling in the digital networked world of the 21st century," *J. Comput. Assist. Learn.*, vol. 29, no. 5, pp. 403–413, 2013.
9. J. P. Gee, "Digital media and learning as an emerging field, part I: How we got here," *Int. J. Learn. Media*, vol. 1, no. 2, pp. 13–23, 2009.
10. W. Barber, S. King, and S. Buchanan, "Problem based learning and authentic assessment in digital pedagogy: Embracing the role of collaborative communities.," *Electron. J. e-Learning*, vol. 13, no. 2, pp. 59–67, 2015.
11. C. Nanjundaswamy, S. Baskaran, and M. H. Leela, "Digital Pedagogy for Sustainable Learning.," *Shanlax Int. J. Educ.*, vol. 9, no. 3, pp. 179–185, 2021.
12. C. F. Pasani, R. Amelia, and Z. Hassanhassan, "Covid-19 impact in Indonesia's education sector: Challenges and strategy," *J. Adv. Res. Dyn. Control Syst.*, vol. 12, no. 7 Special Issue, pp. 1722–1731, 2020, <https://doi.org/10.5373/JARDCS/V12SP7/20202281>.
13. R. Amelia, S. I. A. Dwiningrum, and A. Mustadi, "Pandemic Pedagogy in The Era of Digital Transformation," in *ICLIQE 2021: Proceeding of The 5th International Conference on Learning Innovation and Quality Education*, 2021, pp. 1–7.
14. J. Whalen, "Should teachers be trained in emergency remote teaching? Lessons learned from the COVID-19 pandemic," *J. Technol. Teach. Educ.*, vol. 28, no. 2, pp. 189–199, 2020.
15. L. Kaye, *Young children in a digital age: Supporting learning and development with technology in early years*. Routledge, 2016.
16. W. B. (IBRD), "Teacher certification and beyond: An empirical evaluation of the teacher certification program and education quality improvements in Indonesia," 2016.
17. A. B. Ragatz, "Indonesia-A video study of teaching practices in TIMSS eighth grade mathematics classrooms: understanding what teaching practices are used, why they are used and how they relate to student learning," *The World Bank*, 2015.
18. H. Fitria, M. Kristiawan, and N. Rahmat, "Upaya Meningkatkan Kompetensi Guru Melalui Pelatihan Penelitian Tindakan Kelas," *Abdimas Unwahas*, vol. 4, no. 1, 2019.
19. M. FARISI, "Developing the 21st-century social studies skills through technology integration," *Turkish Online J. Distance Educ.*, vol. 17, no. 1, pp. 16–30, 2016.
20. N. M. A. W. Putri, "Digital Transformation: The Approach to Society 5.0 in Indonesia," in *2021 2nd International Conference on ICT for Rural Development (IC-ICTRuDev)*, 2021, pp. 1–5.
21. D. Mhlanga and T. Moloi, "COVID-19 and the Digital Transformation of Education: What Are We Learning on 4IR in South Africa?," *Educ. Sci.*, vol. 10, no. 7, p. 180, 2020.
22. B. B. Lockee, "Shifting digital, shifting context:(re) considering teacher professional development for online and blended learning in the COVID-19 era," *Educ. Technol. Res. Dev.*, vol. 69, no. 1, pp. 17–20, 2021.

23. T. Purcărea and A. Purcărea, "Services marketing in the era of disruption and digital transformation," *Rom. Econ. Bus. Rev.*, vol. 12, no. 4, pp. 7–26, 2017.
24. S. Ramadhan, E. Sukma, and V. Indriyani, "Teacher competence in utilizing digital media literacy in education," in *Journal of Physics: Conference Series*, 2019, vol. 1339, no. 1, p. 12111.
25. G. M. G. Kizi, "Developing diagnostic assessment, assessment for learning and assessment of learning competence via task based language teaching," *Acad. Globe Inderscience Res.*, vol. 3, no. 04, pp. 34–38, 2022.
26. R. Raja and P. C. Nagasubramani, "Impact of modern technology in education," *J. Appl. Adv. Res.*, vol. 3, no. 1, pp. 33–35, 2018.
27. D. Hawkrigde, *New information technology in education*. Taylor & Francis, 2022.
28. R. Krishan, "Technology in Education vs Teacher-Taught Relationship in the 21st Century," in *Edutech Enabled Teaching*, Chapman and Hall/CRC, pp. 217–224.
29. K. Murkatik, E. Harapan, and D. Wardiah, "The influence of professional and pedagogic competence on teacher's performance," *J. Soc. Work Sci. Educ.*, vol. 1, no. 1, pp. 58–69, 2020.
30. H. N. Supkhonovna, "Technology for the development of the qualities of pedagogical competence in future teachers," *Asian J. Multidimens. Res.*, vol. 10, no. 5, pp. 372–382, 2021.
31. Y. Sudargini and A. Purwanto, "the Effect of Teachers Pedagogic Competency on the Learning Outcomes of Students," *J. Ind. Eng. Manag. Res.*, vol. 1, no. 4, pp. 1–8, 2020.
32. C. Senturk and G. Zeybek, "Teaching-learning conceptions and pedagogical competence perceptions of teachers: A correlational research," *Res. Pedagog.*, vol. 9, no. 1, pp. 65–80, 2019.
33. U. Rusilowati and W. Wahyudi, "The significance of educator certification in developing pedagogy, personality, social and professional competencies," in *2nd Social and Humaniora Research Symposium (SoRes 2019)*, 2020, pp. 446–451.
34. S. Yamnoon, "Education 4.0, Teaching and Learning in 21 th Century," Thailand, TRU, 2018.
35. Z. I. Almarzooq, M. Lopes, and A. Kochar, "Virtual learning during the COVID-19 pandemic: a disruptive technology in graduate medical education," *Journal of the American College of Cardiology*, vol. 75, no. 20. American College of Cardiology Foundation Washington DC, pp. 2635–2638, 2020.
36. C. F. Pasani, R. Amelia, and Z. Hassan, "LEARNING LOSS AND EDUCATION INEQUALITY IN INDONESIA (MAPPING THE POTENTIAL, CONSEQUENCES, AND THE COVID-19 CRISIS)," *Rev. Int. Geogr. Educ. Online*, vol. 11, no. 10, pp. 1171–1181, 2021.
37. I. N. Umar and N. A. Jalil, "ICT skills, practices and barriers of its use among secondary school students," *Procedia-Social Behav. Sci.*, vol. 46, pp. 5672–5676, 2012.
38. S. E. Juliansyah Noor, *Metodologi Penelitian: Skripsi, Tesis, Disertasi & Karya Ilmiah*. Prenada Media, 2016.
39. J. W. Creswell and C. N. Poth, *Qualitative inquiry and research design: Choosing among five approaches*. Sage publications, 2017.
40. R. Wilding, B. Wagner, C. Colicchia, and F. Strozzi, "Supply chain risk management: a new methodology for a systematic literature review," *Supply Chain Manag. An Int. J.*, 2012.
41. A. van Rooyen, "Collaborative exploration of language teachers' digital didactical designs for tablet classrooms." University of Pretoria (South Africa), 2021.
42. F. D. Guillén-Gámez, M. Mayorga-Fernández, J. Bravo-Agapito, and D. Escribano-Ortiz, "Analysis of teachers' pedagogical digital competence: Identification of factors predicting their acquisition," *Technol. Knowl. Learn.*, vol. 26, no. 3, pp. 481–498, 2021.
43. I. Engeness, "Developing teachers' digital identity: towards the pedagogic design principles of digital environments to enhance students' learning in the 21st century," *Eur. J. Teach. Educ.*, vol. 44, no. 1, pp. 96–114, 2021.

44. M. V Moiseienko, N. V Moiseienko, I. V Kohut, and A. E. Kiv, "Digital competence of pedagogical university student: definition, structure and didactical conditions of formation," 2020.
45. I. Jahnke, E. Mårell-Olsson, L. Norqvist, A. Olsson, and A. Norberg, "Digital didactical designs–reimagining designs for teaching and learning," 2014.
46. L. O. Häll, I. Jahnke, and P. Bergström, "Digital Didactical Designs for tablets: experiences from Finland," 2015.
47. D. Gnaur, "Digital didactical designs in multimodal, hybrid learning environments," in THE ASSOCIATION OF VISUAL PEDAGOGY CONFERENCE (AVPC) 2017 AT AALBORG UNIVERSITY, DENMARK, 2017, pp. 34–42.
48. I. Jahnke, L. Norqvist, and A. Olsson, "Digital didactical designs of learning expeditions," in European Conference on Technology Enhanced Learning, 2014, pp. 165–178.
49. I. Jahnke, A. Olsson, A. Norberg, and L. Norqvist, "Digital didactical designs: Re-imagining designs for teaching and learning using media tablets," *EUNIS J. High. Educ.*, 2014.
50. I. Jahnke and S. Kumar, "Digital didactical designs: Teachers' integration of iPads for learning-centered processes," *J. Digit. Learn. Teach. Educ.*, vol. 30, no. 3, pp. 81–88, 2014.
51. Z.-J. Liu, N. Tretyakova, V. Fedorov, and M. Kharakhordina, "Digital literacy and digital didactics as the basis for new learning models development," *Int. J. Emerg. Technol. Learn.*, vol. 15, no. 14, pp. 4–18, 2020.
52. V. I. Toktarova and D. A. Semenova, "Digital pedagogy: analysis, requirements and experience of implementation," in *Journal of Physics: Conference Series*, 2020, vol. 1691, no. 1, p. 12112.
53. M. Huda and K. S. M. Teh, "Empowering professional and ethical competence on reflective teaching practice in digital era," in *Mentorship Strategies in Teacher Education*, IGI Global, 2018, pp. 136–152.
54. T. Sh, "General Didactic Principles of Pedagogical Technologies," *J. Pedagog. Invent. Pract.*, vol. 6, pp. 94–97, 2022.
55. J. From, "Pedagogical Digital Competence--Between Values, Knowledge and Skills.," *High. Educ. Stud.*, vol. 7, no. 2, pp. 43–50, 2017.
56. B. Robandi, E. Kurniati, and R. P. Sari, "Pedagogy in the era of Industrial Revolution 4.0," in *8th UPI-UPSI International Conference 2018 (UPI-UPSI 2018)*, 2019, pp. 38–46.
57. M. Vallance, "Work-in-progress: Didactical Design for Virtual Reality Education," in *2021 IEEE International Conference on Engineering, Technology & Education (TALE)*, 2021, pp. 1167–1170.
58. N. Lorenzo and R. Gallon, "Smart pedagogy for smart learning," in *Didactics of smart pedagogy*, Springer, 2019, pp. 41–69.
59. P. Bergström and E. Mårell-Olsson, "Swedish teachers' didactical design from students' perspective: perspectives on digital competences," 2017.
60. T. Mutton, "Teacher education and Covid-19: responses and opportunities for new pedagogical initiatives." Taylor & Francis, 2020.
61. J. S. Silva, M. U. Usart, J.-L. L.-C. Lázaro-Cantabrana, J. Silva, M. Usart, and J.-L. Lázaro-Cantabrana, "Teacher's digital competence among final year Pedagogy students in Chile and Uruguay," *Comun. Media Educ. Res. J.*, vol. 27, no. 2, 2019.
62. P. Bergström, E. Mårell-Olsson, and I. Jahnke, "Teachers' Digital Didactical Design: Towards Maker Movement Pedagogies In Tablet Mediated Learning," 2015.
63. C. Bonnes, C. Leiser, B. Schmidt-Hertha, K. J. Rott, and S. Hochholdinger, "The relationship between trainers' media-didactical competence and media-didactical self-efficacy, attitudes and use of digital media in training," *Int. J. Train. Dev.*, vol. 24, no. 1, pp. 74–88, 2020.
64. K. Kereluik, P. Mishra, C. Fahnoe, and L. Terry, "What knowledge is of most worth: Teacher knowledge for 21st century learning," *J. Digit. Learn. Teach. Educ.*, vol. 29, no. 4, pp. 127–140, 2013.

65. A. Collins and R. Halverson, “The second educational revolution: Rethinking education in the age of technology,” *J. Comput. Assist. Learn.*, vol. 26, no. 1, pp. 18–27, 2010.
66. R. Schwartzman, “Performing pandemic pedagogy,” *Commun. Educ.*, vol. 69, no. 4, pp. 502–517, 2020.

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