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Teaching and Learning In Digital Technology Era: Method, Material Design and Media

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ABSTRACT

This study presents a systematic literature review that focuse on learning models, strategies, and the design of digital teaching materials in the context of education in the digital era. Drawing from 38 peer-reviewed articles published between 2018 and 2023, this study explores how digital technology has transformed pedagogical practices. The analysis revealed a strong emphasis on student-centered learning models, in which students actively construct knowledge and develop problem-solving skills rather than passively receiving information. Learning strategies, such as problem-based, project-based, and research-based learning, are widely promoted to foster critical thinking, creativity, communication, and collaboration. A key finding was the increasing adoption of blended learning, which combines face-to-face instruction with online platforms, thereby supporting more flexible and interactive educational experiences. However, the success of these strategies depends heavily on educators' digital literacy, especially their competence in integrating technology with pedagogy and content. The design of digital teaching materials must also be aligned with learning objectives and students' needs. Effective materials incorporate diverse formats, such as infographics, videos, podcasts, and virtual labs, and are grounded in principles of relevance, consistency, and adequacy. This study concludes that digital pedagogy is becoming more widely implemented in Indonesia's educational landscape. To ensure its effectiveness, educators must be equipped with adequate ICT skills, supported by a proper infrastructure, and encouraged to collaborate with students for continuous improvement. Using the right approach, digital technology can enhance educational outcomes, promote lifelong learning, and respond to the evolving needs of students in a technology-driven society.

Keywords: teaching, learning, digital, models, design strategies, materials, media

I. INTRODUCTION

The use of technology in learning has opened new avenues of accessibility and flexibility. Previously, learning was limited to textbooks and traditional classrooms. However, with the emergence of digital tools, such as mobile apps, educational software, and online learning platforms, students can now access study materials anytime and anywhere. Digital learning has become increasingly familiar to the public since the COVID-19 pandemic has changed the digital education landscape in various fields including digital content and platforms, infrastructure, and digital skills. Government and private sector responses haves significantly encouraged the uptake of digital education [1].

Technology has provided various online resources to help enrich learning. Learning media such as websites, blogs, podcasts, videos, and online forums offer opportunities to listen, read, write, and communicate globally. In this way, students can exchange information and develop insights and knowledge in the fields in which they are interested. In addition to accessibility and resources, technology has introduced interactive and engaging learning methods. However, despite the positive impact of technology on learning, there are challenges to overcome. For some teachers, limited knowledge and mastery of learning technology tools are obstacle [2]. However, some students may be too dependent on technology and lack direct interaction with humans, which

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can affect their speaking and listening development [3]. Education in the digital era emphasizes wider interactions through information and communication technologies. The involvement of this technology allows the use of video tutorials, internet games, online quizzes, and various forms of interaction through cyber networks. It is important to define the pedagogical challenges of engaging in such technologies. The first step is to examine what is needed for learning by reviewing existing learning theories in order to build a pedagogical framework that can address existing challenges. In the Industrial Revolution 4.0 era, education was the main pillar for change in a better direction to keep pace with developments in science and technology [4]. However, not everyone has access to technology or other online resources.

Digital technology and online resources have opened the door to more inclusive, interactive, and flexible learning but have also presented challenges. This has been recognized in several studies, such as Putrawangsa (2018) [5], Rahman (2018) [6], Afif (2019) [7], Purfitasari (2019) [8], Syammsuar (2019) [9], Anantyarta (2020) [10], Fredlina (2021) [11], Halik (2021) [12], Jumareng (2021) [13], Arianto (2022) [14], Mayulu (2022) [15], Siregar (2022) [2], Salsabila (2023) [16], and Subroto (2023) [17]. In this digital era, it is important for educators and educational institutions to follow the latest developments and adapt learning models, methods, and strategies to current technological developments. This can be done through the design of the learning materials and media used.

Using the internet as an information and communication technology product has become a part of our lives, allowing us to access information from all over the world. The presence of the internet also brings convenience to the world of education, one of which is as a provider of digital learning media, which is increasingly in demand and researched [16]. Digital-based learning media refer to the use of digital technology in the learning process. Computers, mobile devices, the internet, special software, apps, and other types of digital media can be used. This method combines interactive, visual, and audio elements, allowing students to actively and deeply learn. Learning has become more interesting, interactive, and immersive with digital technology [18].

By effectively utilizing the potential of technology, learning can become interesting, interactive, and relevant to the real world. Technology is not merely a tool but also a way to enrich learning and help students achieve learning goals. Digital-based learning media provide students with broad access, flexibility, and a creative learning environment. The use of this medium provides a more in-depth and realistic learning experience.

Since the outbreak of the Covid-19 pandemic, the digitalization of learning has become increasingly common. However, the extent to which educators view learning digitalization is worth knowing. This is useful as a basis for understanding how teachers in Indonesia adapt to the demands of the digital era by examining the methods, media, and development of learning materials that have been used recently. Therefore, this article was prepared to explain this phenomenon.

II. METHODS

This study used a literature review method and a systematic review technique. To address these problems, a literature review was conducted on published articles and reports related to the topic of the problem [19]. The stages followed in this research include 1) the preparation stage, which involves the search for topics and problems that are presented in the article. The second stage is a theoretical study and data collection, in which relevant theories are collected regarding the topic to be discussed. The third stage was data analysis, in which the articles were analyzed according to the topic of discussion. The fourth stage is a discussion and conclusions, where the results of the analysis are presented, discussed, and summarized [20].

The data source was published online articles. The author searched for articles from various journals relevant to discussing learning in the era of digital technology. The articles sampled in this research are published articles discussing strategy, design, and learning methods in the digital era, published in the last five years, namely, from 2018 to 2023. These articles were published in reputable journals and indexed in national databases. A total of 38 articles were identified based on this research topic. Data were collected based on discussion criteria and research questions. After analyzing the results, the data are presented in tables and graphs, followed by a discussion.

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III. RESULTS AND DISCUSSION

A. Results

Based on an analysis of 38 research articles related to teaching and learning in the digital era, the findings were divided into methods, models, strategies, material design, and learning media as follows:

Table 1. Learning Models, Strategies, and Methods in the Digital Era

No	Topics	Articles
A	Teaching and Learning Models	
1	Student Centered	16
2	Teacher centered	2
B	Learning Strategies	
1	Face to face	9
2	Blended Learning (hybrid courses)	14
C	Learning Method	
1	Lecture-based instruction	2
2	Discussion	7
3	Simulation	6
D	Teaching and Learning Strategies	
1	Contextual teaching and learning	3
2	Active learning	5
3	Problem based learning	9
4	Cooperative learning	2
5	Project based learning	17
6	Research based learning	8

As presented in Table 1, in terms of learning models, most researchers discuss the use of student-centered learning as suitable for learning and teaching in the digital era. Blended learning is a suitable method for learning system. In terms of learning methods, most studies have revealed that the discussion method is the most suitable. The most commonly recommended learning strategies are project-, problem-, and research-based.

Table 2. Learning Materials Design and Media

No	Topics	Articles
A	E-Learning Platforms	
1	Massive Online Open Course (MOOC)	14
2	Learning Management System (LMS)	12
B	Digital-Based Teaching Materials	
1	Infographics	5
2	Video Explainer	4
4	Electronic book	21
5	Podcast	11
6	Virtual Lab	1
7	Live Streaming	6
C	Teaching Material Development Model	
1	ASSURE Model	3
2	ADDIE Model	5

Based on Table 2, the most popular platforms are MOOC and LMS. The digital-based teaching materials most often used are electronic books, podcasts, live-streaming videos, and infographics. The most frequently

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recommended model for developing teaching materials is the Analysis, Design, Development, Implementation, and Evaluation (ADDIE) model.

B. Discussion

1. Learning Model

Based on the analysis, it was found that most of the articles analyzed discussed student-centered learning models. In this learning model, students are placed as learning subjects who actively develop their interests and potential [21], [22]. Students are no longer required to listen to and memorize lesson material provided by the teacher, but try to construct their knowledge and skills according to their capacity and level of thinking development, while being invited to contribute to solving real problems that occur in society.

With the student-centered learning method, students are expected to produce outputs to improve student quality, obtain the best graduates, and obtain employment opportunities according to their field [23]. Students are required to be active and independent in their learning process, as well as responsible and take the initiative in recognizing their learning needs, being able to explore sources of information to find answers to what they need by building and presenting their knowledge. The role of the teacher in the digital learning model is to manage and utilize information technology appropriately to achieve meaningful learning goals and improve the quality of learning [21].

2. Learning Strategies and Methods

The choice of learning strategies in the digital era needs to be supported by educators competence as actors in preparing learning strategies and materials [24]. Educators must have technological, content, and pedagogical knowledge. Meanwhile, students need to have technical abilities, creativity, and innovative problem-solving skills [25], [26].

In the digital era, recommended learning strategies increase critical thinking, creativity, communication, and collaboration. These learning strategies are found in problem-based, project-based, and research-based learning [27] [28] [29] [30] [31]. Problem-based learning begins with problems, explores knowledge and skills, solves problems and applications, and ends with reflection. The most prominent characteristic of problem-based learning is that the problems presented are authentic problems and collaborations with small groups to develop their knowledge. The effectiveness of this learning strategy is to increase curiosity, high-level thinking abilities, and participant competence. Problem-Based Learning builds a socially caring character, as supported by research that states that the application of problem-based learning can improve learning outcomes. Students may apply their knowledge to the real world by solving problems and developing an interest in learning continuously through problem-solving, even though they have completed their formal education [32].

Project-based learning is a process-centered, relatively time-framed, problem-focused, meaningful learning unit that combines concepts from several components, such as knowledge, scientific disciplines, or fields. Its characteristics include helping students design a process to determine an outcome, training students to be responsible for managing information carried out on a project, and finally, students producing a real product by themselves and presenting it in class [27]. It provides new experiences and knowledge for students who indirectly experience the scientist's actions in carrying out tasks and solving problems. In other words, it can increase student creativity [31].

Research-based learning developed in universities can foster learning, critical, and communication abilities [28]. In terms of using research, not only students but educators are also required to increase their understanding of expressing themselves in the field of media literacy, understand the information that will be shared with students, and find an analysis to solve digital literacy academic problems. For universities, research-based learning strategies build students' abilities to conduct research and compose scientific papers better because students have experience observing and solving problems [33].

Most of the learning methods in the digital era that are widely discussed in the articles studied are blended learning methods, namely, a combination of face-to-face and online learning methods [14], [15], [22], [34], [35], [36], [37]. Blended learning is supported by an effective combination of delivery methods, teaching methods, and different learning styles and is found in open communication between all parts involved in learning. In this learning system, there is aninteraction between teachers and students [36].Web-based digital platforms for learning are commonly used by several educational institutions. The virtual learning environment

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offers a learning system with various components, where students can obtain all the material and submit assignment results via the Web (38). Various types of websites and applicationshave been developed to provide virtual learning.

In blended learning, teacher creativity is needed to present learning materials, while in face-to-face classes, students can practice their ability to communicate well, and can also help them to be active in the learning process, such as during discussions, students are trained in two things:being able to respect other people's opinions and broaden students' insight [34]. However, the challenge in using the blended learning method is that the digital infrastructure is unevenly distributed throughout Indonesia, which is related to access to adequate Internet quality [14].

3. Learning Materials Design and Media

Material design and learning media are topics of interest in various studies [3], [21], [18], [39], [40]. Many teaching materials are available onlinein digital form. However, digital teaching materials must be designed in a way that suits the learning field and topic. It should be noted that teaching materials should consider student-centered, self-determined, research-based, and digital-based learning. This type of teaching material can be packaged in the form of infographics, explainer videos, electronic books, podcasts, virtual labs, live streaming videos, etc. [12].

Access to material links is essential for tracing the sources of teaching materials, especially digital-based ones. The selection of teaching materials must consider principles of relevance, consistency, and sufficiency. The relevance shows that teaching materials must be based on competency standards (learning outcomes) relevant to students' conditions, learning strategies and methods, learning media, and learning evaluation systems. The principle of consistency describes the existence of unity between first and final materials. Moreover, learning outcomes and approaches were also observased. The principle of adequacy is significant because the teaching materials used are representative. Adequacy covers aspects of scientific materials and digital literature sources and is in line with the learning outcomes to be achieved [18].

The ends of digital-based learning media are Infographics, Video Explainers, MotionGraphics, Interactive Multimedia, Vlogs, Private Online, Mobile Apps, Electronic Books (Interactive Electronic Books, PDF Books, and Audio Books), Podcasts, Virtual Labs, Gamification, Virtual Classes, Mat Web Application, Augmented Reality-Math, Virtual Reality-Math, 3DAnimation, and Live Streaming Video [12]. Digital media are widely available on the Internet cloud and are easily accessible for use both free and paid. Digital media options are a challenge for lecturers in developing research-based digital learning because the students are of the millennial generation who are familiar with information and technology communication [41].

Digital teaching materials must be well-designed. Effective teaching materials are interesting, easy to absorb, focus attention, and exciting [21]. Students in learning need a varied stimulus that is digital-based, encourages exploration and innovation, and provides challenges. For students of the millennial generation, the digital approach is a big attraction for learning and opens up opportunities to be more creative and develop their potential. The preparation of teaching materials should consider elements of novelty, ease of use, accessibility, communication, and stimulation. Thus, it motivates students to learning process [42]. The ADDIE model is an approach that helps designers or teachers create efficient and effective teaching designs. This model consists of four components: analysis, design, development, implementation, and evaluation [43].

Learning strategies should be considered during the material-design phase. It was found that problem-based and research-based learning materials increased the meaningfulness of digital learning so that they were contextual through the presentation of research results. It strengthens students' thinking abilities as researchers, increases their understanding of the development of science through continuous research, and improves the quality of learning [12].

The novelty aspect allows teaching materials to be in line with the dynamics of the times, thereby providing something new and adding value to students. In terms of proximity, teaching materials are adapted to the reach of reason and appear to be experienced or felt directly in life so that they are easier to apply. Interesting teaching materials encourage students to provide responses and critical analysis of the object of study. The teaching materials are designed for students to feel relaxed by interspersing with humor so that students feel content [12].

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IV.CONCLUSIONS

Technological developments continue to change priorities regarding what should be taught and learned and how to convey it. Technically, education in the digital era is pedagogy that optimizes the use of communication technology accompanied by character education. The conclusions from 28 published articles concerning digital pedagogy are as follows: 1) there has been a strengthening of the concept of digital pedagogy in the last three years in Indonesia, accompanied by an increase in learning models with the concept of blended learning, namely a combination of face-to-face and online learning. 2) Along with addition, teachers should have ICT literacy in the use of digital media for teaching and learning activities. The importance of competency in mastering digital teaching materials and strategies. Teachers require communication skills using technological devices to effectively design and deliver the materials they teach. 3) Digital teaching and learning requires adequate equipment and technology support and is available in all regions of Indonesia. 4) Collaboration between teachers and students is also important for maximizing the impact of technology on learning. Learners may provide feedback on their experiences using digital tools and resources, allowing teachers to continually improve and refine their technology-based learning methods. With a proper approach, technology can be a powerful tool for achieving educational goals.

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