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TPACK and Teachers' Digital Competence in the Era of Industry 4.0

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Abstract

The impact of the Industrial Revolution 4.0 era extends to all aspects of human life, including education. Professional teachers play a crucial role in fostering effective learning and improving student outcomes. It is expected that teachers not only possess technological proficiency but also integrate it seamlessly into their daily teaching practices. Therefore, it is important to analyse how teachers' digital competence can overcome the challenges of era 4.0, as well as the role of Technological Pedagogical Content Knowledge (TPACK) in improving their competence. This study employs a literature review to analyse teachers' digital competence in era 4.0 and the associated challenges, as well as to explain the role of TPACK in improving their digital competence. This study employs a literature review to analyse teachers' digital competence in era 4.0 and the associated challenges, as well as to explain the role of TPACK in improving their digital competence. The study's results demonstrate that teachers face several challenges in improving their digital competencies, including transforming learning models, developing digital competencies, understanding students' individual needs, and integrating learning using current technologies such as artificial intelligence (AI) and internet-based learning applications. In the 4.0 era, TPACK plays a crucial role in enhancing teachers' digital competencies. TPACK provides a holistic approach that integrates three main dimensions of knowledge.

Keywords : *TPACK, Digital Competency, Teachers, Era 4.0.*

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Introduction

The discussion about Era 4.0 and technological change and the role of teachers in managing change is still a hot topic. Era 4.0 marks a major shift in the world of technology that has a significant impact on various aspects of life. The Industrial Revolution 4.0 era has implications that are not simple. It affects all aspects of human life. This includes education [1]. Rapid technological changes such as artificial intelligence, the Internet of Things and big data are the main drivers of this era [2]. Changes in automation innovation with the creation of supercomputers, robotic artificial intelligence and genetic modification are creating a world that is very different from the previous one [3].

Teachers are very important in providing knowledge to students (Nurkholis & Badawi, 2019), so teachers or educators are one of the determinants of achieving national education goals [4].Professional teachers are an important element in creating effective learning and better students [5].Teachers are expected not only to master technology but also to integrate it effectively in their daily teaching. This is certainly not separate from

the goal of education in the industrial era 4.0 to produce education graduates who are competent in the current era, not only able to use ICT, but also capable and competent in literacy, critical thinking, problem solving, communication, collaboration and have good character qualities [2].

Teachers must have competence in the use of technology and information in learning, because when learning takes place, teachers also shape their students' competence in the use of technology [6].This is in line with the research conducted by (Afrianto, 2018), which showed that among the adaptations and changes that teachers need to make is the change in thinking about the role of teachers and the learning process, where teachers also need to carry out adaptation programmes, such as adapting curriculum content to content that prepares students with 21st century skills, and also selecting and implementing various current learning models that are suitable for millennium generation students [7]. These efforts are made in order to prepare superior human resources with global competence and to be able to adapt to the existing era, even though information technology is developing so rapidly and learning resources are so easily available, the role of teachers as educators cannot be replaced by these technological advances if they are able to adapt [8].

If teachers are not creative and innovative, they will take second place to the gadgets.Conventional learning strategies are no longer relevant because students are bound to get bored with the classroom atmosphere [9]. Teaching means that teachers must pass on and develop science and technology to students. Education means that teachers must be able to transmit and develop the value of life to students [10].

The relationship between teachers' digital literacy and Era 4.0 is crucial in facing the profound changes brought about by the latest industrial revolution. Era 4.0, characterised by the development of digital technologies such as artificial intelligence, the Internet of Things and big data, requires teachers with strong digital literacy.Teachers who understand and master technology are not only able to integrate it into the learning process, but also have the capacity to guide students to develop skills relevant to future needs.Teachers' digital literacy is the foundation for creating a learning environment that is innovative, responsive and in line with the dynamics of Era 4.0. Teachers who are able to guide students to understand, master and use technology effectively will help produce a generation that is ready to face global change, contribute to technological development and play an active role in the advancement of a technology-based society. Thus, the close relationship between teachers' digital literacy and Era 4.0 provides a strong foundation for relevant and competitive education in the
21st century. Therefore, it is worth analysing how teachers' digital literacies meet the challenges of Era 4.0 and the role of TPACK in improving teachers' digital literacies in Era 4.0.

Methods

The method we will use is a literature review with the aim of analysing the digital competence of teachers in the 4.0 era and knowing the challenges.Then the role of TPACK in improving teachers' digital literacy will be explained.A literature review is a written summary of articles from journals, books and other documents that describe

theories and information both past and present, organising the literature into the topics and documents needed [11].

The data used is data from articles published in educational journals and non-educational journals; explanations of teachers' digital literacy, era 4.0 and the TPACK concept were obtained from articles in published journals.This data was then processed and presented in a descriptive manner according to the research topic.

Results and Discussion

Teachers' Digital Competence in the Era 4.0

Teachers' digital competence is the teacher's ability to use digital tools and information and communication technology based on pedagogical principles by realising all its implications in educational methodology [12].Competency is an Indonesian word derived from the English word competency.Competence can be interpreted as a skill, ability or authority. According to Nana Syaodih (1997), competence is a performance that leads to the complete achievement of goals towards the desired conditions.Meanwhile, Spencer (2007) says that competence is a characteristic that underlies behaviour and describes the motives, personal characteristics, self-concept, values, knowledge or expertise that a superior performer brings to the workplace [13].

According to (Prayogi & Estetika, 2019), digital literacy includes several forms, namely: information (literacy skills), communication (ability to interact through digital technology and media), educational content creation (ability to create digital learning content or media), security (ability to protect against the effects of learning content or media), and educational problem solving (ability to solve problems related to technology-based learning) [14].

As we move into the 21st century, one aspect that cannot be ignored is the influence of Information and Communication Technology (ICT) [15].Teachers' digital competence is a crucial aspect in an increasingly digitalised educational era.First of all, teachers need to have a deep understanding of ICT.This includes knowledge of hardware, software and applications that can be used to enhance the learning process. Digitally literate teachers are able to integrate these technologies well into the curriculum to provide a more engaging and effective learning experience for students.

According to Sanjaya (2006) as cited by Latif, there are seven roles of teachers in digital era learning, namely: (1) teacher as a learning resource; (2) teacher as a facilitator; (3) teacher as a manager; (4) teacher as a demonstrator; (5) teacher as a guide; (6) teacher as a motivator; and (7) teacher as an elevator [16]. This means that in this digital era, the role of a teacher in learning is not only as a source and carrier of information to students. However, everything related to the student learning process is organised and planned by the teacher before the learning takes place.

The importance of teachers' digital competence also includes the ability to adapt to changing technological developments, to understand digital ethics and to teach students to be responsible users of technology. This is in line with the Minister of National Education's Regulation No. 16 of 2007, which states that a teacher must be competent in information and communication technology [17]. Teachers who are digitally literate can create immersive and relevant learning experiences, increase

student engagement, and prepare students to succeed in an information technology-based society. In other words, teachers' digital literacy is not only about the use of technological tools, but also about how these technologies can be effectively integrated to enhance students' learning experiences in the digital age. In the educational process, the importance of the teacher's role in learning activities is emphasised, which means that teachers need to help students acquire skills and knowledge based on educational objectives [18].

Teachers' digital literacy is not only about technical skills, but also about how to effectively use these technologies to enhance learning and prepare students for success in an increasingly digitally connected world.

The world in general, and Indonesia in particular, is entering a new industrial era characterised by digitalisation in various aspects of life. This era is known as the Industrial Revolution 4.0, which refers to a stage of industrial development characterised by the integration of advanced digital technologies into various aspects of life and production [6]. The concept encompasses profound changes in the way people interact with technology, in the production of goods and services, and in social and economic dynamics.

Industrial Age 4.0, also known as Industrial Revolution 4.0, refers to a period of industrial transformation characterised by the integration of advanced technologies and deep digitalisation in production processes and everyday life. This era is an evolution of the previous Industrial Revolution, with a focus on the use of information technology, artificial intelligence, the Internet of Things (IoT), big data and various other emerging technologies. The Industrial 4.0 era will have a significant impact on various areas of life, including industry, the economy, education and society in general.

The Fourth Industrial Revolution has the potential to raise global income levels and improve the quality of life for the global community, will lead to low and competitive prices, increase efficiency and productivity, lower transport and communication costs, increase the effectiveness of logistics and global supply chains, reduce trade costs, open new markets and stimulate economic growth [2].

In the world of education, the 4.0 era is bringing about significant changes in several areas. Learning, teachers, teaching media, learning techniques, even down to students' learning activities. Teachers, as the controllers of learning, cannot simply accept all these changes. In this era, teachers are challenged to transform learning models, develop digital literacy, understand students' individual needs, and integrate learning using current technologies such as artificial intelligence (AI) and web-based learning applications.

The role of TPACK in improving teachers' digital literacy

TPACK stands for "Technological Pedagogical Content Knowledge" in Bahasa Indonesia. The TPACK concept was introduced by Mishra and Koehler in 2006 to describe the kind of knowledge teachers need to integrate technology into the teaching and learning process. Matthew J. Koehler and Punya Mishra introduced the concept of TPACK (Technological Pedagogical Content Knowledge) to respond to the needs and detail the type of knowledge required by teachers in dealing with the use of technology in the context of learning [19].

Technology Content Pedagogy Knowledge (TPACK) is a productive approach to learning because it combines elements of content knowledge, pedagogy and technology. Learning methods guided by the TPACK structure are used to address the learning problems of students who have little understanding of the content of the lessons being taught. Therefore, by adopting this TPACK structure, it is possible to make complex learning methods understandable to learners by using technology to make them easier to understand [20].

TPACK consists of seven components that explain the interrelationship between technology, pedagogy and content. TPACK consists of CK, PK, PCK, TPK AND TPACK [21]. First, content knowledge (CK) is knowledge about the content or subject matter that teachers need to learn and that students need to learn. Second, technological knowledge (TK) is knowledge about different types of technology as tools, processes and sources. Third, pedagogical knowledge (PK) is knowledge about the theory and practice of planning, managing and assessing learning, or how teachers manage classroom activities to achieve learning goals. Fourth, pedagogical content knowledge (PCK) is pedagogical knowledge related to specific content. Fifth, technological pedagogical knowledge (TPK) is knowledge about different technologies that can be used to facilitate learning and teaching. Sixth, technological content knowledge (TCK) is knowledge about the interrelationship between technology and content. Seventh, TPACK or pedagogical and content technology knowledge is knowledge about the appropriate use of technology on appropriate pedagogy to teach a content well [22].

TPACK is the most effective tool and way to explore teachers' ability to master technology and their ability to use technology for learning [23]. According to the TPACK framework, when using technology tools, teachers not only need to have access to and be able to use the technology, but they also need to pay close attention to the ability of the technology to solve learning problems. This can be interpreted to mean that teachers need to make decisions about how to identify, adapt and also implement learning that matches pedagogy and technology that can add value to learning in the classroom.

The Technological Pedagogical Content Knowledge (TPACK) framework has significant implications for teachers and teacher educators. The Technological Pedagogical Content Knowledge (TPACK) framework describes the different types of knowledge that teachers need to teach effectively using technology and various complex knowledge interaction processes [22]. The role of TPACK in improving teachers' digital literacy can be seen in several ways, namely:

1. Improved Integration of Technology, Pedagogy, and Content

The TPACK framework enables teachers to not only possess knowledge of technology but also to understand how to integrate it with pedagogical and content knowledge. This results in the creation of more effective and relevant learning experiences.

2. Acquisition of skills in designing technology-based learning. Teachers who possess a good understanding of TPACK can develop skills in designing technology-based learning activities that enhance students' understanding of the subject matter, leading to increased student engagement.

3. TPACK can help teachers

TPACK can assist teachers in making learning more engaging and increasing student participation. Technology can be utilised to create interactive learning experiences, promote collaboration, and encourage active student involvement in the learning process.

4. Personalisation of Learning

Using TPACK, teachers can personalise learning according to students' needs and learning styles by understanding how to incorporate technology. They can select digital tools and resources that align with students' level of understanding and interest.

5. Assessment with Technology Integration

Teachers who possess good TPACK can design assessment methods that are integrated with technology. They can use tools and applications to monitor and evaluate student progress more efficiently, provide faster feedback, and support the learning process.

6. Appropriate Training and Professional Development

TPACK can guide training and professional development initiatives for teachers. The training should focus on developing the skills necessary to effectively integrate technology, enrich learning, and improve student outcomes.

7. Teaching Flexibility

Teachers who possess Technological Pedagogical Content Knowledge (TPACK) can be more adaptable in integrating technology into different learning environments. They can modify their teaching methods based on the requirements of their students and use technology appropriately in various learning situations.

Overall, the Technological Pedagogical Content Knowledge (TPACK) framework is a robust tool for enhancing teachers' digital proficiency, empowering them to be more efficient in integrating technology into their teaching methodologies.

To effectively integrate technology into learning, teachers must adopt a holistic and planned approach. Firstly, teachers must understand both the subject matter being taught (content knowledge) and how best to deliver it to students (pedagogical knowledge). With this understanding, teachers can identify points in the curriculum where technology can add value, increase student engagement, and broaden the learning experience. Furthermore, teachers should carefully select technology tools and resources that align with their learning objectives and students' learning styles. Online platforms, learning apps, and digital resources should be integrated into lesson plans in a coherent and structured manner.

It is important for teachers to facilitate student collaboration and engagement in the use of technology. This can be achieved through the use of online forums, collaborative tools, and technology-based projects, which encourage active student participation and shape an inclusive learning environment. Teachers should continuously develop their technology skills, keep abreast of the latest developments, and participate in professional training that focuses on technology integration. With this approach, teachers can create learning experiences that are engaging, relevant and prepare students for the demands of an increasingly digitalised world.

Conclusion

The challenges of Era 4.0 require teachers to improve their digital competence. This includes transforming learning models, developing digital competencies, understanding individual student needs, and integrating current technologies such as artificial intelligence (AI) and internet-based learning applications. It is important for teachers to not only be aware of the latest technological developments but also to be able to effectively incorporate them into the learning process.

TPACK plays a crucial role in enhancing teachers' digital competence in the 4.0 era. It offers a holistic approach that integrates three key knowledge dimensions: technological knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK), to develop a deeper understanding of how to use technology effectively in the context of teaching and learning.

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