# Deep Dive into Teachers' Digital Competence to Support 21ˢᵗ Century Learning: A Systematic Literature Review

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**Abstract**: Teachers' digital competence (TDC) should be possessed by teachers in the 21st century learning process because learning resources in this era are not only from one source but many sources along with technological developments. This study aimed to provide an overview of the dimensions of TDC, the level of TDC, obstacles, and solutions to improve teachers' digital competence. Data were collected through Sinta, Emerald, Elsavier, Wiley, IEEE, Taylor & Francis, ERIC, JSTOR Journals, MDPI, and Springer. From these, 47 articles were investigated to address the focus of this research issue. The results show that the dimension of TDC widely used was the DigCompEdu 2.0 framework from the European Commission. Based on TDCs' classification using teacher competence as stated in Indonesia's Law No. 14 of 2005, previous researchers tended to discuss the dimensions of TDC which focused on professional competence (46.67%), pedagogic competence (29.33%), social competence (12%), and personality competence (16%). Furthermore, teachers' average digital competence is still low. So, collaboration between the government and the school and organizing teacher training is needed to improve teacher digital competence. This study also revealed that heutagogy and synchronous collaborative learning models could be used to enhance TDC in the 21st century.


**Keywords:** Teachers' digital competence, Tecahers' digital competence dimensions, Twenty-First century learning

## Introduction


Twenty-First Century learning prioritizes the ability to use the internet and access learning technology. Learning

resources in 21st century learning come not only from one source but many sources along with technological developments. Teachers can combine appropriate learning models with technology to achieve learning objectives during the learning process. Research shows that digital tools and software are positioned as learning resources with better results than traditional teaching-learning resources (Reimers & Schleicher, 2020; Uluyol & Şahin, 2016). Chalkiadaki (2018) visualizes 21st century learning as an era primarily characterized by the evolution of technology and ICT, globalization, and innovation, consequently highlighting the need for students to develop relevant skills and competencies. A class dominated by Generation Z (1996-2009) encourages teachers to have adequate digital competence because that generation has the best digital abilities (Basantes-Andrade et al., 2020).

Previous literature has finally begun to develop the definition of teachers' digital competence needed in using technology in the classroom (From, 2017; Krumsvik et al., 2016). From (2017) defines teachers' digital competence as using Information and Communication Technology (ICT) such as digital tools or software. Other researchers define teachers' digital competence as a complex ability, such as teachers' ability when use technology tools and digital resources. Teachers' digital competence considers dimensions, attitudes, strategies, and awareness that enable teachers to effectively use effective technology to achieve teaching and learning goals. European Framework for the Digital Competence of Educators (DigCompEdu) considers digital competence as the technology safely, critically, and creatively to enrich teaching and learning objectives (Redecker & Punie, 2017).

The discussion of teacher digital competence is closely related to using digital learning technology. Digital learning technology tools are currently being developed to support the learning and teaching process in the classroom that promotes the implementation of 21st century learning. Several government policies have made efforts to ensure teachers have used technology in 21st century learning, such as organizing teacher training and empowerment programs. That programs aimed at accelerating the use of technology in education, such as the Lifelong Learning Strategy 2020 in Estonia (2014), the Good School Reform in Italy (2015), the Curriculum Reformation in Finlandia (2016), and Ayo Guru Belajar by the Indonesian Ministry of Education and Culture (2020). Although the government and schools have met the availability of hardware and software, using digital tools in learning practices and digital competence is still foreign to educators (Cattaneo et al., 2022). This condition shows that the completeness of the infrastructure only partially or not thoroughly explains the use of technology (Drossel & Eickelmann, 2017). The International Computer and Information Literacy Study (2018) documented that less than 50% of teachers use technology in their learning process (Fraillon et al., 2018). The Organization for Economic Co-operation and Development (OECD) Teaching and Learning International Survey results show that in training on technology-related skills, only 43% of teachers feel ready to use technology in teaching (OECD, 2019). In fact, due to the increasing demands for the use of technology in education during the COVID-19 pandemic teachers from 64 different countries worldwide are showing a diversity of their readiness to use technology in teaching (Scherer et al., 2021).

A country with big 4 world-population like Indonesia is expected to have gold generation in 2045. Besides, the

Internet users who are at the age of secondary and tertiary education (13-24 years) are 31.61% of the Indonesian population (BPS-Statistics Indonesia, 2021). This opportunity should encourage regulators to make policies regarding the existence of teacher digital competencies in basic teacher competencies that stated in The Law Number (No).14 of 2005 concerning teachers and lecturers. Based on the law, teacher competencies that must be possessed by teachers are pedagogic competence, personal competence, social competence, and professional competence that obtained through professional education. Teacher competency standards cover core teacher competencies which are developed into competencies for kindergarten teachers, Elementary School teachers, Junior High School Teachers, Senior High School Teachers, and Vocational High School Teachers. For vocational education, Sajidan et al. (2016) stated that the ability to operate technology is one of the assets that teachers must have in this digital age. Therefore, teacher digital competence should be included in the teacher professional education curriculum, so that pre-service teachers who graduate have competencies that are appropriate to their era, namely teacher digital competence.

The use of technology by teachers in the teaching and learning process has a significant impact on student learning outcomes. Students will achieve better learning outcomes when their teachers perceive that learning management systems are easy to use and learn (Cobo-Rendon et al., 2021). Using digital is meaningful for self-expression and is part of digital competence (Ala-Mutka, 2011; Eshet-Alkalai, 2004). Teachers who desire and can integrate ICT during the learning process will be better at communicating educational goals and have clear expectations about ICT use, provided they have mastered digital competencies. Meanwhile, teachers who have no desire or are unable to implement ICT in teaching and learning activities may have problems conveying lesson objectives and expectations (Moltudal et al., 2019). Nouri et al. (2020) revealed that digital competence includes advanced skills for creating materials, problem-solving, collaboration, and innovation. The benefits of using technology in the classroom if it is not supported by the digital competence of the teacher cause the learning objectives not to be achieved. Furthermore, the level of maturity in mastering digital competencies is one aspect that has an essential role in supporting the transformation of the learning industry 4.0 (Bergdahl et al., 2020; Rizaldi et al., 2020).

This phenomenon triggers researchers to provide an overview of the teachers' digital dimensions and the latest conditions related to teacher digital competence research in the 21st century. The study has a significant meaning considering teacher digital competence related to 21st century teacher competence, both at the elementary school, high school, and college levels. This systematic research literature review also offers solutions about suitable learning models to improve teacher competence in 21st century learning because selecting appropriate learning models and designs can assist teachers in implementing effective learning and using technology (Conole, 2013). Regarding the researcher's knowledge, no research discusses the four basic of teachers' competence that mentioned in Indonesia's Law Number (No). 14 of 2005 as a basic competence to develop the comprehensive of teachers' digital competence. Besides, this study tries to elaborate the learning models that can improve teachers' digital competence in 21st century learning using a systematic literature review.

## Method

This systematic literature review study aims to provide an overview of the condition of digital competence in 21st century learning. To solve the problem, the researcher conducted a literature review using the procedure suggested by Cooper (1988) for literature synthesis. Systematic methods help to 1) formulate problem topics, 2) collect data, 3) select data through predetermined criteria, 4) analyze and interpret data, and 5) organize and discuss research results. Based on the phenomenon of teachers' digital competence described in 21st century learning, this systematic literature review is used to answer three questions as guidelines. First, the Author intended to elaborate on the dimensions of teacher digital competence used in relevant current research. Secondly, to investigate the digital competence status of teachers. Thirdly, describe the obstacles faced by teachers in improving digital competence. Last, the Author tried to provide the solution teachers can use to overcome the barriers to increasing digital competence. The next step of this systematic literature review is to identify and explain all the questions above to conduct an SLR study based on the literature that has been collected.

The data collected for the empirical study used a qualitative approach. The keywords used are "teachers' digital competence," "21st century learning competence", "ICT competence," and "teachers' digital competence and level." Other keywords were also used, such as "teacher and technology" and "teachers' perception of digital competence."

Records identified through Sinta, Emerald, Elsavier, Wiley, IEEE, Taylor & Francis, ERIC, JSTOR Journals, MDPI, Springer database searching (n=315)

⬇

Records after duplicate removed (n=290) ——— Records excluded (n=205)

⬇

Records after applying inclusion and exclusion criteria (n=85) ——— Records excluded (n=30)

⬇

Studies included in synthesis (n=55)

⬇

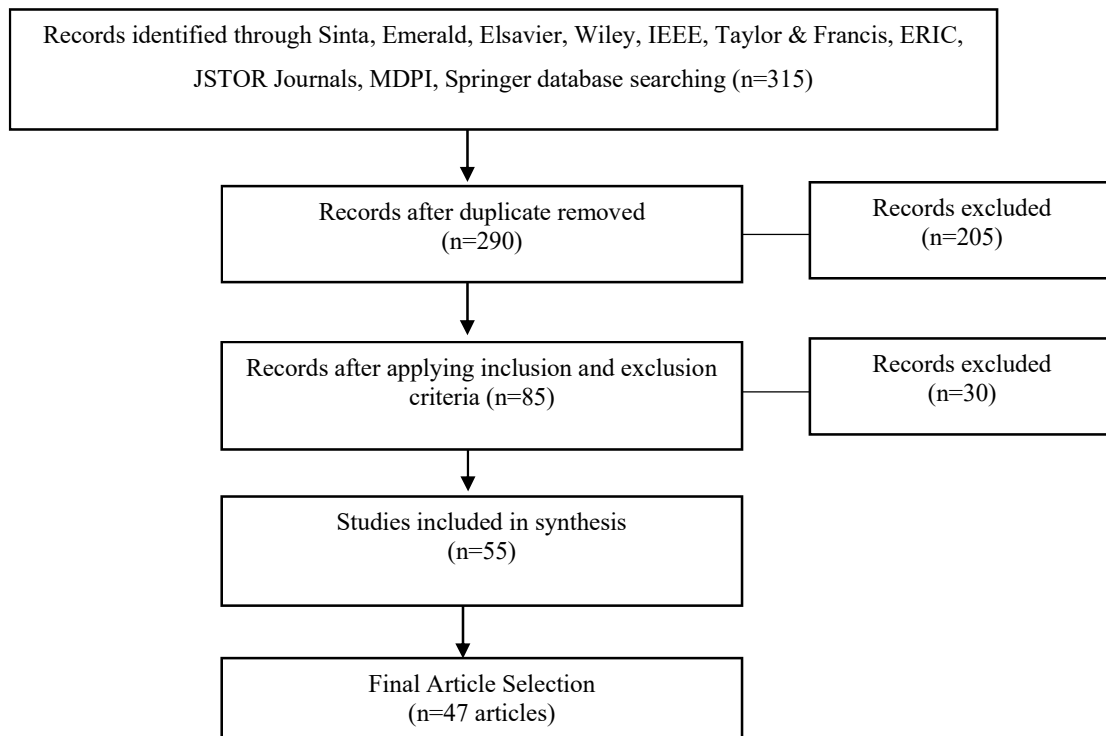Final Article Selection (n=47 articles)

Figure 1. Flow Diagram of the Publication Selection Process

Table 1. Inclusion and Exclusion Criteria

| Type of criterion | Criteria | Inclusion | Exclusion |
|---|---|---|---|
| Type of publication | Journal articles | √ | |
| | Conference papers | √ | |
| | Reports | √ | |
| | 21st century framework | √ | |
| | Teachers' digital competence framework | √ | |
| | Dissertation | √ | |
| | Books | √ | |
| Access | Online | √ | |
| | Offline | | √ |
| Publication period | 2009-2022 | √ | |
| Publication issue | Are written in English | √ | |
| | Are not written in English | | √ |
| | Have been published after being submitted to a peer-review process | √ | |
| | The full version of the publication is available through the subscription of our institutions | √ | |
| | The research follows the appropriate structure of analysis according to the research method | √ | |
| Place of study | Empirical investigation | √ | |
| | Theoretical studies | √ | |
| Research methods | Qualitative | √ | |
| | Quantitative | √ | |

## Results

The inclusion criteria allow the analysis of publications from 2009 to 2022. Table 2 showed that the most citation article was dominated by 2021 publication or 29,79% of as many as 14 articles.

Table 2. Number of Publications each Year Used in Research

| Year | 2009 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| n | 1 | 1 | 2 | - | 3 | 3 | 5 | 4 | 3 | 6 | 14 | 5 |

Fourty-seven articles were found and used in a systematic literature review through a predetermined procedure. Of the 47 articles that appeared as samples in this study, the identification results showed 21 countries with Spain as a country that produced many articles related to the problem topics. In addition, one of the articles on Digital Teacher competency by European Framework for the Digital Competence of Educators (Redecker &

Punie, 2017) is not included in the worldwide popular distribution and number of selected studies (Figure 2). 15 articles focus on the issue of the dimensions of teacher competence used in this study, 17 articles focus on the case of the level or condition of teacher digital competence, and 19 articles focus on the issue of constraints and solutions offered to improve teacher digital competence. The same six articles are used on the digital competence level of teachers and the case of obstacles and solutions for increasing digital competence. For clarity, the use of articles can be seen in the Venn diagram (Figure 3). In addition, Table 3 presents the citation of the sources used in the results section.



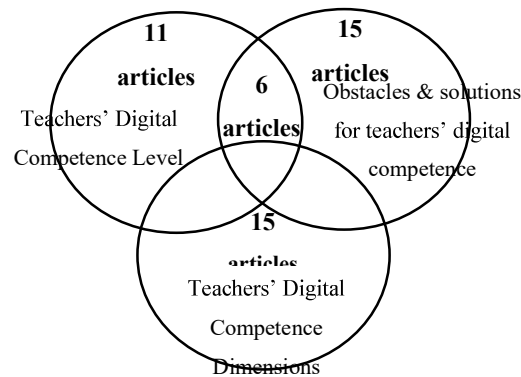Figure 2. Worldwide popularity and number selected studies



Figure 3. Article Division according to the State of Problem

Table 3. References of Teachers' Digital Competence Dimensions

| Focus | Reference |
|---|---|
| Teachers' Digital Competence Dimensions | Cattaneo et al., 2022; Dervenis & Fitsilis, 2022; Pérez-Calderón et al., 2021; Alarcón et al., 2020; Kim & Choi 2018; Touron et al., 2018; Al Akhateeb |

| Focus | Reference |
|---|---|
| (15) | 2017; Elstad & Christophersen 2017; Kelentrić et al., 2017; Krumsvik et al., 2016; Redecker & Punie, 2017; Tondeur et al., 2017; Siddiq et al., 2016; Walker & White, 2015; Pavlova, 2009 |
| Teachers' Digital Competence Level (17) | Astuti et al., 2021; Basantes-Andrade et al., 2020; Basilotta-Gómez-Pablos et al., 2022; Benali et al., 2018; Bilbao-Aiastui et al., 2021; Cabero-Almenara et al., 2021; Diz-otero et al., 2022; Fraile et al., 2018; Gámez et al., 2022; Garzón-Artacho et al., 2021; Guillén-Gámez et al., 2020; Hamzah, 2021; Mutohhari et al., 2021; Portillo et al., 2020; Prieto-Ballester et al., 2021; Supardi & Hakim, 2021; Zhao et al., 2021 |
| Obstacles and Solutions for Increasing Teachers' digital Competence (21) | Agonács & Matos, 2019; Arredondo-Trapero et al., 2021; Astuti et al., 2021; Basilotta-Gómez-Pablos et al., 2022; Blaschke & Hase, 2016; Blaschke & Marin, 2020; Blaschke, 2012; Conole, 2013; Enochsson et al., 2021; Fraile et al., 2018; Instefjord & Munthe, 2015; Isoda et al., 2021; Kožuh et al., 2021; Lu et al., 2015; Mutohhari et al., 2021; Moltudal et al., 2019; Ortega-Sánchez et al., 2020; Portillo et al., 2020; Supardi & Hakim, 2021; Wannapiroon et al., 2021; Wastiau et al., 2013 |

**Teachers' Digital Competence Dimension**

The results of research on the dimensions of teacher digital competence are shown in Table 4. There are 15 models of teacher digital competence along with their dimensions. Furthermore, to make it easier to identify the dimensions of each teacher competency model, the basic Indonesian teacher competencies are used in this stydy, so that it is known which components are more dominant (professionalism, pedagogical, social, and personality).

Table 4. Model Framework of Teachers' Digital Competence

| Model Framework/ Resource | Area/Dimension of Teachers' Digital Competence | Indonesian Teachers' Competence | | | | % |
|---|---|---|---|---|---|---|
| | | Profesion alism | Pedag ogical | Social | Persona lity | |
| Maturity Level using Technology (Pavlova, 2009) | Technological Awarness | √ | | | | PF=100% |
| | Technological Literacy | √ | | | | |
| | Technological Capability | √ | | | | |
| | Technological Creativity | √ | | | | |
| | Technological Critism | √ | | | | |
| Digital competence for linguistic competence | Procedural Competence | √ | | | | PF=50% |
| | Social-Digital competence | | | √ | | PD= 25% |
| | | | | | | SC= 25% |
| | Digital Discourse | √ | | | | |

| Framework | Dimension | | | | | Percentage |
|---|---|---|---|---|---|---|
| (Walker & White, (2015) | Competence | | | | | |
| | Strategic Competence | | √ | | | |
| Teachers' Professional Digital Competence (Krumsvik et al., 2016) | Elementary ICT | √ | | | | PF= 60% |
| | Basic ICT Skills | √ | | | | PD=40% |
| | Didactic ICT Competence | | √ | | | |
| | Digital Learning Strategies | | √ | | | |
| | Digital Bildung | √ | | | | |
| Teachers' Emphasis on Developing Students' Digital Information & Communication Skills (TEDDICS) (Siddiq et al., 2016) | Acces Digital Information | √ | | | | PF= 66,66% |
| | Evaluate Digital Information | √ | | | | SC= 33,33% |
| | Share and Communicate Digital Information | | | √ | | |
| Digital Competence of teachers (the uses of ICT resources to support student with disabilities) (Cabero-Almenara et al., 2016) | General aspect of the application of ICT for people with disabilities | √ | | | | PF= 100% |
| | Application of ICT with Motor | √ | | | | |
| | Application of ICT with Visual | √ | | | | |
| | Application of ICT with Hearing | √ | | | | |
| | Application of ICT with Cognitive | √ | | | | |
| DIGCOMP-EDU 2.0 (Redecker & Punie, 2017) | Profesional engagement | √ | | | | PF= 33,34 |
| | Digital Resources | | √ | | | PD= 66,68 |
| | Teaching and Learning | | √ | | | |
| | Empowering Students | | √ | | | |
| | Assessment | | √ | | | |
| | Facilitating Students' Digital Competence | √ | | | | |
| Digital | Self-efficacy for | | | | √ | PS= 100% |

| Model | Dimension | | | | | Results |
|---|---|---|---|---|---|---|
| Competency among Student Teachers (Elstad & Christophersen, 2017) | maintaining discipline Self-efficacy for influencing students' use of ICT in learning | | | | √ | |
| Pre-Service Teachers' ICT Competencies (Toundeur et al., 2017) | Competencies to support pupils for ICT use in class | | √ | | | PF= 50% PD= 50% |
| | Competencies to use ICT for instructional design | √ | | | | |
| Common Framework for TDC (INTEF, 2017) | IT information and Literacy Information | √ | | | | PF= 50% SC= 50% |
| | Communicating and Collaborationg | | | √ | | |
| Teachers' Professional Digital Competence (Kelentrić et al., 2017) | Topics and basic skill | √ | | | | PF= 21,44% |
| | School in Socienty | | | √ | | PD= 28,58% |
| | Ethics | | | | √ | SC= 28,58% |
| | Pedagogy and didactics | | √ | | | PS= 21,44% |
| | The leadership of learning processes | | √ | | | |
| | Interaction and communication | | | √ | | |
| | Change and development | √ | | | √ | |
| S.A.F.E Model (Digital Citizenship Scale) (Kim & Choi, 2018) | Self-identity in digital environment | | | | √ | PF= 40% PS= 60% |
| | Activity in online | √ | | | | |
| | Social/cultural engagement | | | | √ | |
| | Fluency for digital tools | √ | | | | |
| | Ethics for digital environment | | | | √ | |
| Eucators' Digital Competence (the DIGIGLO) (Alarcón et al., 2020) | Professional engagement | √ | | | | PF= 18,75% |
| | Digital resources | | √ | | | PD= 56,25% |
| | Teaching and learning | | √ | | | SC= 37,5% |
| | Assessment | | √ | | | |
| | Empowering | | √ | | | |
| | Facilitating learners' | √ | √ | | | |
| | Digital environment | | | √ | | |

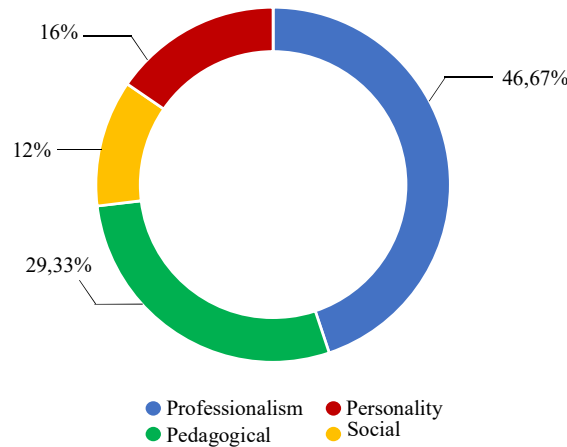| | | Col1 | Col2 | Col3 | Col4 | |
|---|---|---|---|---|---|---|
| | Extrinsic digital engament | | | √ | | |
| Digital Competence of Educators (Guillén-Gámez et al., 2020) | Duties of the tutor in relation to the student body | | | | √ | PF=30% PD= 10% PS= 60% |
| | Duties of the tutor in relation to the teaching staff | | | | √ | |
| | The tutors' role with the family | | | | √ | |
| | ICT and transfer | √ | | | | |
| | Use of ICT resources | √ | √ | | | |
| Teachers' Digital Competence for Vocational Education and Training (VET) (Cattaneo et al., 2022) | Communication and collaboration | | | √ | | PF= 20% PD= 60% SC= 10% PS= 10% |
| | Professional development | √ | | | | |
| | Digital resources selection | | √ | | | |
| | Digital ressources creation | | √ | | | |
| | Data protection | | | | √ | |
| | Teaching and learning | | √ | | | |
| | Assessment | | √ | | | |
| | Students' empowerment | | √ | | | |
| | Media education | | √ | | | |
| | Students' digital competence | √ | | | | |
| Teachers' Digital Competence in Higher Education (Dervenis & Fitsilis, 2022) | Personality | | | | √ | PF= 66,68% PS= 16,67% PS= 16,67% |
| | Professionalism | √ | | | | |
| | Educational | √ | | | | |
| | Scientificity | √ | | | | |
| | Communication | | | √ | | |
| | Digitality | √ | | | | |
| | N | 35 | 22 | 9 | 12 | |
| | N (Total) | 75 | 75 | 75 | 75 | |
| | % | **46,67** | **29,33** | **12** | **16** | |

Figure 4. Classification of Teachers' Digital Competence Dimensions

## Discussion

### Teachers' Digital Competence Dimensions

The model that are usually used are DigCompEdu 2.0 (Redecker & Punie, 2017) and INTEF from Ministry of Education, Government of Spain (INTEF, 2017). First, framework model discussed in this section is the DigCompEdu 2.0 framework from the European Commission. The DigCompEdu 2.0 framework model has three main parts: teachers' professional competence, which discusses professional engagement; teachers' pedagogic competence, which includes digital resources, teaching, learning, empowering students, and assessment; and student's competence which provides for facilitating students' digital competence. Several studies adopted this model, namely, Alarcón et al. (2020), Benali et al. (2018), Bilbao-Aiastui et al. (2021), Cattaneo et al. (2022), Lucas et al. (2021), Fraile et al. (2018), and Portillo et al. (2020). Second, model from the Common framework for digital teaching competence model from INTEF (Spanish Ministry of Education), which has five dimensions, namely, information, communication, content creation, security, and problem-solving. This model was adopted by Fraile et al. (2018) and Garzón-Artacho et al. (2021).

Teachers' digital dimensions from 15 articles were designed based on the learning subject or students faced by the teacher. For example, Walker & White (2015) discussed teachers' digital competence in linguistics, Cabero-Almenara et al. (2016) revealed teacher digital competence for students with disabilities, Cattaneo et al. (2022) showed the digital competence of vocational teachers, and Dervenis & Fetsilis (2022) showed the digital competence of lecturers. In addition, each dimension that has been suggested has a tendency to develop teacher digital competence from several sides, such as Guillén-Gámez et al. (2020) which tends to focus on digital social skills, namely on the digital abilities of teachers with students, staff, and student families. Then Elstad & Christoperses (2017) prioritize self-efficacy or teacher internal factors in using technology. Not only that, some researchers also tend to prioritize dimensions related to digital-pedagogic teachers in learning, such as assessment, determining digital sources, teaching, learning, communication, etc.

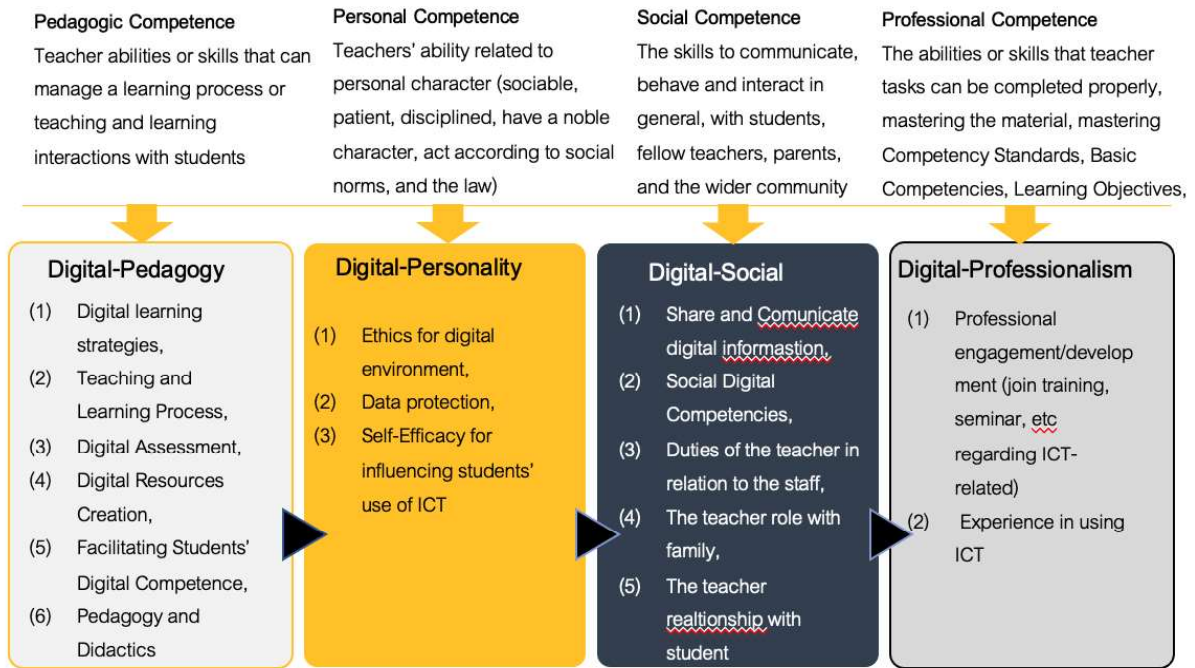**Teachers' Competence in Indonesia (Based on The Law Number 14 of 2005)**

**Pedagogic Competence**
Teacher abilities or skills that can manage a learning process or teaching and learning interactions with students

**Personal Competence**
Teachers' ability related to personal character (sociable, patient, disciplined, have a noble character, act according to social norms, and the law)

**Social Competence**
The skills to communicate, behave and interact in general, with students, fellow teachers, parents, and the wider community

**Professional Competence**
The abilities or skills that teacher tasks can be completed properly, mastering the material, mastering Competency Standards, Basic Competencies, Learning Objectives,

**Digital-Pedagogy**
(1) Digital learning strategies,
(2) Teaching and Learning Process,
(3) Digital Assessment,
(4) Digital Resources Creation,
(5) Facilitating Students' Digital Competence,
(6) Pedagogy and Didactics

**Digital-Personality**
(1) Ethics for digital environment,
(2) Data protection,
(3) Self-Efficacy for influencing students' use of ICT

**Digital-Social**
(1) Share and Comunicate digital informastion,
(2) Social Digital Competencies,
(3) Duties of the teacher in relation to the staff,
(4) The teacher role with family,
(5) The teacher realtionship with student

**Digital-Professionalism**
(1) Professional engagement/development (join training, seminar, etc regarding ICT-related)
(2) Experience in using ICT

Figure 5. The Extended of Teachers' Digital Competence

The existence of differences in the perspectives of previous researchers in forming the dimensions of teacher digital competence has led to a tendency for the digital dimension of teacher competence in certain contexts, for example in professional, pedagogic, social, or personality contexts. One of the policies in Indonesia, teachers from various levels of education must fulfill the basic teacher competencies, including pedagogic competence, personal competence, social competence, and professional competence (Indonesia's Law Number (No). 14 of 2005). Research result showed on Figure 4, professionalism competence of teacher becomes the most concern of previous researchers in developing teachers's digital competence. This study in line with Dervenis & Fitsilis (2022), from 34 articles out of 39, have addressed the "professionalism", suggesting its necessity. The characteristics of Professionalism is the subject of one's professional activity in relation to how specialized a teacher is and how recognized he/she is in the field in which they teach. It also refers to how well he/she knows and applies methods and principles that govern their field while ensuring the interconnection between theory and practice (Dervenis & Fitsilis, 2022). Besides, Previous researchers did not pay much attention to the social and personality aspects of a teacher when building digital competence. To complete the gap, Figure 5 presents the dimensions of teachers' digital competence which are adjusted to the basic competencies. So, it can produce a more comprehensive dimension of teacher digital competence. Please note, Table 4 has several dimensions with different name but having same meaning. To make sure there are no duplicate words in every teacher competence, this study will choose the word that best represents each competency.

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**Teachers' Digital Competence Level**

The collected teacher digital competence research was carried out using different dimensions (Table 4). Although using a different dimension, the researchers showed that the level of teacher competence was at a low level (Astuti et al., 2021; Benali et al., 2018; Diz-otero et al., 2022; Fraile et al., 2018; Garzón-Artacho et al., 2021; Mutohhari et al., 2021; Portillo et al., 2020; Suoh iypardi & Hakim, 2021; Zhao et al., 2021). Teachers' digital competence is said to be low because teachers do not understand specific competencies. The author divided two factors that make teachers' digital competence still low, namely internal and external factors. For internal factors, Teachers still have low scores on the ability to create, understand information literacy, and improve their problem-solving skills (Fraile et al., 2018; Garzón-Artacho et al., 2021), to ensure communication security (except for the protection of digital data and digital identity), content creation ability (Benali et al., 2018; Fraile et al., 2018), caring, capability, creativity, critical, and lack of years of experience in using digital technology (Astuti et al., 2021), teachers' knowledge of technology and teachers' using media (Diz-otero et al., 2022). For external factors, teachers only have a short time to attend training in the field of digital skills (Portillo et al., 2020), teachers do not use multi-media technology in the learning process (Supardi & Hakim, 2021), teachers only using low technology quality and the lack of available laboratories (Mutohhari et al., 2021).

The level of digital competence is at a medium to low level (Basilotta-Gómez-Pablos et al., 2022; Cabero-Almenara et al., 2021). Based on the literature study, it can be seen that the average digital competence of teachers is still low. For medium to low level of teachers' digital competence, even though the school is equipped with facilities and infrastructure, there are still digital competencies that need to be improved and that teachers need to understand, namely the evaluation competence of educational practice (Basilotta-Gómez-Pablos et al., 2022). Teachers who do not know digital learning resources fall into the medium to low category.

For medium level of teachers' digital competence (Benali et al., 2018; Bilbao-Aiastui et al., 2021; Guillén-Gámez et al., 2020; Prieto-Ballester et al., 2021), teachers need to improve the components of reflective practice and Learner empowerment and facilitate Students' Digital Competence. Besides, empowering students and ensuring facilities can support students' digital competence. In addition, teachers who do not adequately use ICT tools contribute to the digital competence of medium teachers (Guillén-Gámez et al., 2020).

Teachers identified as having a high level of digital competence can be found in teachers who have the drive to operate technology in learning. Hamzah (2021) stated that after the COVID-19 pandemic, digital teaching abilities were at a high level. Meanwhile, Benali et al. (2018) revealed that teachers with high digital competence have high trust when using technology and teachers with years of experience.

**Obstacles to Increasing Digital Competence**

The literature study results show that teachers' average digital competence is still low. The low digital competence of teachers is due to the obstacles experienced by teachers during the learning process and obstacles

that slow down the improvement of teacher digital competencies. The barriers experienced by teachers include the conditions of ICT infrastructure in the school, digital in curricula, and Teachers' motivation to understand digital competence.

*ICT Infrastructure in School*

Adequate digital competence of teachers in schools can be concluded as a practice in which at least there is an excellent technological infrastructure, teachers with a high level of technological-pedagogical knowledge, and well-functioning technology-mediated communication and administration (Olofsson et al., 2019). The school's ICT infrastructure needed to implement technology-based learning is at least the availability of a desktop computer; mobile devices such as laptops, notebooks, tablets, smartphones, etc.; broadband; school website, email addresses, virtual learning environment, etc.; deployment of equipment in classrooms, computer labs, libraries, etc.; maintenance (Wastiau et al., 2013).

School students who are dominated by a technology-literate generation make students able to operate gadgets more dexterously, especially in generation Z (Basantes-Andrade et al., 2020). These phenomena make students addicted to social media and entertainment content on social media. So, schools and teachers need to make school infrastructure an essential point in creating a digital environment. Moltudal et al. (2019) emphasize that the lack of ICT infrastructure dominates classroom management problems compared to teacher pedagogical problems. Teachers using low technology and schools with few laboratories lead to low teacher digital competence (Mutohhari et al., 2021). Furthermore, it should be noted that school infrastructure in rural and urban areas also affects the improvement of teacher competence. The condition of school infrastructure for teachers who teach in rural areas is different for teachers who teach in urban areas. So, teachers in rural areas are less motivated to develop strategies for using ICT than teachers in urban areas (Arredondo-Trapero et al., 2021). In addition, when teachers already have the motivation to use technology in classroom learning, other obstacles make it difficult for teachers to apply technology in the classroom, namely weak economic resources and the few students who have mobile phones (Enochsson et al., 2021). This condition contributes as an obstacle to increasing teacher digital competence.

*Digital in Curricula*

One of the obstacles to why digital competence is still low is that there is no discussion of technology in curriculum documents. There needs to be an integration of ICT into the curriculum (Arredondo-Trapero et al., 2021). Therefore, for educational institutions that are preparing digital competencies into the school curriculum, schools should develop awareness about teacher technology knowledge that will be integrated into the curriculum (Instefjord & Munthe, 2015). In addition, obstacles to increasing digital competence can be overcome by efforts to raise capital and social law and regulate one's resilience from an education system related to the SDGs (Portillo et al., 2020).

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*Teachers' motivation to understand digital competence*

Teacher motivation in using digital in learning is one of the factors that can develop teacher knowledge about digital learning resources (Cabero-Almenara et al., 2021). Moltudal et al. (2019) stated that the teacher is the party responsible for facilitating the learning process with ICT. Teachers with less motivation tend not to apply technology in the classroom. Meanwhile, teachers who are motivated tend to use technology in the classroom. According to Kožuh et al. (2021), teachers' digital competence can be assessed by the subjects taught. Science and technology teachers use digital tools more often when learning than social humanities teachers. The existence of collaboration between teachers is also able to trigger teachers to use technology. Enochsson et al. (2021) revealed that teachers who have difficulty finding colleagues to collaborate on teaching and learning using learning technology are a cultural challenge that teachers must solve. Teachers need to have high confidence in using technology because teachers who fear being wrong when using technology can reduce their digital competence (Enochsson et al., 2021).

**Solutions to Improve Teacher's Digital Competencies**
*The role of policymakers*

School ICT infrastructure in urban and rural areas has different ways of implementing it. The proportion of ICT infrastructure assistance for schools in rural areas may be more significant than those in urban schools. The current state of each area can be a consideration for the government as the party making policies to overcome ICT infrastructure problems in rural areas by helping to provide facilities, facilities, and infrastructure that support the implementation of technology-based learning. Furthermore, Lu et al. (2015) showed that ICT infrastructure is essential in using technology-based classrooms. The government needs to determine the number of policies to formulate a tight and optimal budget for providing ICT infrastructure in schools. Wastiau et al. (2013) believe that a country's policies can play a significant role in supporting the above policies and actions needed to realize a digital education system, increasing the number of digitally supported schools and teachers, and students who have confidence in using digital education.

*Teacher Training and Empowerment in the Field of Digital Competence*

Concerning preparing digital competencies for teacher candidates currently taking teacher education, Ortega-Sánchez et al. (2020) stated that there is a need for training for prospective teachers or teachers who are already teaching. The training on digital competence given to student-teacher candidates in Spain and France shows differences in self-perceptions about teacher digital competence. The results of this study also indicate a need to improve technological-manipulative and didactic training for teachers in universities and to adapt teachers' digital competencies to the demands of the information communication society. Not only teacher candidates or teacher education students who need to attend training. Teachers who have taught in the world of education also need to improve their digital competence through the implementation of teacher training or empowerment in the areas of digital competence, teacher self-development, and motivation relevant to mastering digital technology

(Astuti et al., 2021; Basilotta-Gómez-Pablos et al., 2022; Kožuh et al., 2021; Mutohhari et al., 2021; Supardi & Hakim, 2021). Kožuh et al. (2021) further agree that teachers often use learning technology tools during the learning process. If teachers desire to follow technological developments and are willing to attend seminars and workshops, they can improve their digital competence.

*Implementing the Twenty-First Century Learning Model*

Research on implementing appropriate learning models to improve teacher digital competence is rarely carried out in systematic literature research. This study describes the efforts that can be used to overcome teachers' digital competence through the application of learning innovations or learning models. Selecting suitable learning models and designs can help teachers learn and use effective technology (Conole, 2013), one of which is heutagogy learning. Heutagogy is ideal for use with online learning or technology components (Agonács & Matos, 2019; Lapele et al., 2022). Heutagogy is a learning theory that prioritizes student-center. Heutagogy is a model that shape self-directed learning, self-determined learning, complexity, reflective practice, constructivism, self-efficacy, zones of proximal development, and transformative education for student (Blaschke, 2012; Blaschke & Marin, 2020). The existence of a person's opportunity to access technology and social media such as blogs, wikis, and social media (Blaschke, 2014) allows heutagogy to develop through the ability to create and share the content, connect and collaborate with others inside and outside the classroom, share experiential learning outcomes and provide students with opportunities to learn from one another, and to reflect on what was learned and how it was learned thereby making learning more personal, independent, and self-determined (Anderson, 2019; Blaschke & Hase, 2016). So that teachers will have a greater incentive to use learning technology during the learning process, especially in terms of presentation preparation. According to Fraile et al. (2018), it is necessary to integrate ICT by combining relational and didactic aspects. The results of other studies provide suggestions so that teachers can implement synchronous collaborative learning, which involves Information and communication technology. The elements that need to be considered are cross-border contexts, classroom arrangements, and collaborative teaching methodology (Isoda et al., 2021; Wannapiroon et al., 2021). Teachers can implement any learning model as long as it integrates technology in the learning model.

## Conclusion

The existence of learning technology in 21st century learning encourages teachers to have good digital competencies. Learning resources in 21st century learning are not only from one source but more than learning resources. In addition, the existence of students (generation Z) who are more sophisticated in using technology increasingly requires teachers to be able to create learning resources through digital technology. Several models of the teacher's digital competence framework determine teachers' digital competence. The DigCompEdu model framework is the framework that researchers use most often. The results showed that the level of digital competence of teachers was still low or at the most basic level.

Furthermore, this is due to several obstacles faced by teachers. This study groups three blocks that cause teachers' digital competence to be still low: the condition of ICT infrastructure in the school, digital curriculum, and Teachers' motivation to understand digital competence. The study's results provide a solution through a systematic literature review. There are three solutions; first, the need for a role from policymakers or the government in creating a digital environment or ICT infrastructure in schools, especially in schools located in rural areas and schools with a high level of education—Economics of students or teachers who are not good. Second, there needs to be training and empowerment of teacher competencies in digital competence to give teachers a better understanding of digital competencies. The third is implementing appropriate learning models in 21st century learning, namely the heutagogy and synchronous collaborative learning models. Heutagogy is a model that integrates technology in it and aims to create self-determined and self-directed learning in students. So, this corresponds to the type of Shiva in the 21st Century.

This research has limitations in its implementation, namely study with research targets at all levels of education, both playground, elementary, secondary, and higher education levels. Further research can focus on only one type of education level to focus more on the problems faced at one level of education. In addition, this study only examined 47 articles collected according to the criteria. Further research can increase the number of articles studied to produce more comprehensive findings.

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