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# Digital competence of science teachers in terms of gender, length of work, and school levels of teaching

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**Abstract**

Technological development in education should be balanced with digital competencies to create optimal education. This development has increased during the pandemic, which requires teachers to master digital competence to organize education for students. This study aims to determine the digital competence of science teachers and investigate differences in gender, length of work, and school levels of teaching. This study employed a cross-sectional survey and involved 105 science teachers in West Java Province, Indonesia. Online questionnaires were used to collect the data. This research has revealed that science teachers have different digital competence at the school level. In contrast, they do not have divergent digital competence regarding gender and length of work. Teachers with good digital competence can develop collaborative learning.

Keywords: Education, Digital Competence, Science Teacher

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## 1. Introduction

### *1.1. Conceptual and Theoretical Framework*

Education must provide human resources to adjust to existing changes and challenges. Such a condition becomes a big challenge because educational institutions should prepare excellent human resources. A challenge in the industrial revolution 4.0 era is building skills and mentality to master competitive advantage (Sony & Naik, 2020). Educators should acquire technological mastery or digital competence to narrow gaps in rapid information development (Portillo et al., 2020).

The education system's digitization requires teachers to have an extra capability, namely digital competence (Tohara, 2021). This competence is needed to prevent teachers and students from being left behind and enable them to answer the challenges of fast-global developments. Digital competence is an aspect that can explain various uses of high-level digital technologies that contribute to the more critical benefits of digital technologies (Hatlevik, 2017). This competence consists of specialized knowledge, motivational aspects, cognitive abilities, and skills (Roll et al., 2020). Digital competence consists of technical skills, the ability to use digital technology meaningfully for working, studying, and performing daily life, the ability to assess digital technology critically, and the motivation to participate and commit to digital culture (Ilomäki et al., 2016).

Digital competence affects students during lessons (Wastiau et al., 2013). Teachers with good digital competence will positively impact their students' learning outcomes (Pettersson, 2018). This statement is supported by Sipilä, who asserts that students need competent and confident teachers who can utilize digital technology. Unfortunately, many teachers still have low-digital competence (Sipilä, 2014). Moreover, their quality to support the use of technology in education is low; thus, they should think creatively and continue learning and accepting development (Zuhairi et al., 2007). Digital competence is a factor that supports the implementation of a quality educational learning process, especially during the Covid-19 pandemic. These phenomena and problems have initiated the need to investigate teachers' digital competence.

Nowadays, several educational media are available for education, and one of them is DigCompEdu, an educational media developed by the European Union Joint Research Center. This media aims to harmonize the educational policy in the European Union. DigCompEdu provides a categorization framework to identify educators' digital competencies (Ghomi & Redecker, 2019). DigCompEdu was created to assist educators in more comprehensively understanding knowledge and skills; thus, they could integrate digital technologies into education meaningfully. DigCompEdu presents six central areas of digital competence for educators at all educational levels, from preschool to college.

Teachers' digital competence could be developed by transferring theoretical knowledge and realistic experience; thus, they could integrate digital technologies into teaching-learning processes (Hinojo-Lucena et al., 2019; Hsu & Lin, 2020; Tusiime, W., Johannesen, M., & Gudmundsdottir, 2019). Digital competence refers to the ability to use information technology for public benefit. This competence includes various skills, such as searching and processing information, identifying factual information through virtual content, and utilizing numerous internet-based tools and services (Ilomäki et al., 2016).

Digital competence consists of six domains or competencies that educators must develop to conduct effective learning. Moreover, its development requires teachers to successfully develop multiple devices to improve their skills (Zhao et al., 2021). Digital competence also includes recognizing educational needs and solving problems conceptually using technology (Harnani et al., 2021). Therefore, digital competence refers to a skill that can improve the quality of life and encourage a sense of empowerment (Harmoko, 2021). Teachers still have a low level of digital content creation of the five digital competencies (Garzón Artacho et al., 2020). Content creation relates to teachers' experience of participating in technological use

skill training. Teachers with less than ten years of teaching have more concerns about this issue. This study describes digital literacy competencies in the school environment, especially among science teachers in Indonesia. The urgency of this paper is to obtain quality information related to the teacher's competence to avoid negative information.

### *1.2. Related Research*

To date, many studies have investigated digital competencies. Blau examined 392 teachers' responses to digital competence and the use of digital content (Blau & Shamir-Inbal, 2017). Meanwhile, Hinojo investigated 140 teachers in Andalusia, Spain, to determine factors influencing their digital competence (Hinojo-Lucena et al., 2019). Pongsakdi examined 98 teachers in southern Finland to explore their confidence levels in using technology predicted for digital competence skills (Pongsakdi et al., 2021). Examined 335 teachers in Germany reviewed the application of digital competencies that support their work (Ghomi & Redecker, 2019). About this issue. Unfortunately, There have not been many studies on this matter in Indonesia. Most of these previous studies have a limited focus on teachers' digital competencies and rely on self-assessment and reflection. Finally, other studies have found that many teachers have low digital competence (Hoesny & Darmayanti, 2021; Meylina et al., 2021). Researchers have gathered data on the digital competence of science teachers in Indonesia. This research on science teachers has not been carried out previously. So needed to analyze the digital competence of science teachers to investigate differences in gender, length of work, and school levels of teaching.

### *1.3. Purpose of the Study*

The purpose of this study is generally to describe the digital competence of madrasah science teachers in Indonesia. This study analyzes teachers' opinions about digital competence based on gender, length of services, and school levels of teaching. In addition, this study also further examines teachers' views on digital competence based on differences in terms of gender, length of work, and school levels of teaching.

## 2. Method and Materials

### *2.1. Research Model*

The research design used in research is a survey research design. This study employed a cross-sectional survey model. This model explores individuals' opinions about an examined subject at a given time (Fraenkel, J. R., Wallen, N. E., & Hyun, 2012). The selection of a cross-sectional survey design was carried out to measure the digital competence of several science teachers as a variable in the study. This is a consideration that the cross-sectional survey design is a survey design popularly used in education and is used to collect information about attitudes, beliefs, opinions, and behaviors with the advantage of being able to present information quickly.

### *2.2. Participants*

Sampling was taken using the Purposive Sampling technique that meets specific criteria. This survey involved as many as 105 science teachers from the province of West Java – Indonesia, various levels of school, years of service, and gender. School levels in Indonesia are grouped into secondary schools, including SMP (n=47) and MTs (n=25), while senior high school includes SMA (n=22) and MA (n=11). Respondents were categorized according to years of service covering 1 – 5 years (n=31), 6 – 10 years (n=15), and more than 10 years (n=59). Respondents were categorized based on gender, including male (n=27) and female (n=78).

### *2.3. Data Collection Tools*

The questionnaire instrument used was adopted and developed based on the DigComp concept. The questionnaire is based on five dimensions or fields, namely information and data literacy, communication and collaboration, digital content creation, security, and problem-solving. The form of developing a digital competency questionnaire was guided by Cebi & Reisoğlu (2020). The results of developing questionnaire items were evaluated by relatives based on their field of expertise to assess the questionnaire items. A 4-scale questionnaire was applied to determine the teacher's digital competence response, namely point 4 for strongly agreeing, point 3 for agreeing, point 2 for disagreeing, and point 1 for strongly disagreeing. The questionnaire was given to the teacher through the google form address.

### *2.4. Data Analysis*

This study uses a descriptive analysis based on the distribution of questionnaires. Assumptions of the analysis test using normality and homogeneity are applied to digital competency data. Because the calculated value is in the range of numbers exceeding 0.05 at the minimum standard of significance, the assumptions of normality and homogeneity are passed. The results of the acquisition of digital competence are calculated for the mean and standard deviation for each of the specified factors. The test of differences in teacher digital competence based on factors is carried out using the ANOVA formula. If there is a significant difference, the LSD test is carried out in an advanced stage to find out in more detail the aspects being measured. In analyzing the data, software assistance is needed, namely IBM SPSS v20.

## 3. Results

### *3.1. Description Data of Science Teacher Digital Competency*

The data of this study were extracted from an online questionnaire filled in by the science teachers as the respondents. The extracted data results were processed and produced a summary of digital competence responses as presented in Table 1. The summary signifies the average digital competence of science teachers and the standard deviation scores. The average score for content creation is the smallest of the other dimensions, while the security dimension has the highest average score. However, the dimensions of information and literacy, communication and collaboration, and problem-solving have similar-average scores. In addition, the standard deviation scores vary for each digital competence dimension, indicating varied data.

**Table 1.**

Results of descriptive analysis of digital competence of science teachers

| Digital Competence Dimensions of Teachers | Statistics | |
|---|---|---|
| | Mean | Std. Deviation |
| Information and data literacy | 17.019 | 2.129 |
| Communication and collaboration | 17.028 | 2.136 |
| Digital content creation | 12.434 | 1.757 |
| Security | 19.434 | 2.669 |
| Problem-solving | 15.896 | 2.169 |

Based on table 1, it is known that the average score for each digital dimension of teacher competence. The security dimension is at the top position, the second position is the communication and collaboration dimension, the third order is the information and literacy dimension, the fourth order is problem-solving, and finally, the digital content dimension is at the bottom. The standard deviation score for each dimension looks different, so the data has a good distribution. These were then examined in more detail by considering specific factors. This comprehensive analysis resulted in descriptive statistics, as presented

in Table 2. This study has revealed that male teachers have a greater average score of digital competence than female teachers. Teachers at a high school level have the best average score for digital competence. Moreover, teachers who have worked for 1-5 years have the best average score for digital competence. The descriptive results of standard deviation scores state that the science teachers' competencies vary

**Table 2.**
Descriptive statistical results of science teachers' competences

| in terms of gender, length of work, and school levels of teaching | Mean | Std. Deviation |
|---|---|---|
| Gender | | |
| Male | 84.37 | 9.36 |
| Female | 80.97 | 9.23 |
| School Levels | | |
| Junior high school (SMP) | 79.91 | 8.06 |
| Islamic junior high school (MTs) | 81.84 | 9.14 |
| Senior high school (SMA) | 87 | 10.81 |
| Islamic senior high school (MA) | 79 | 8.97 |
| Length of Work | | |
| 1-5 years | 84.06 | 9.68 |
| 6-10 years | 82.93 | 10.19 |
| More than 10 years | 80.34 | 8.79 |

Respondents were classified into three factors, namely gender, school level, and years of service. The average dimensions of digital competence are categorized based on these three factors to determine the mapping that occurs. There is a difference in the average digital competency score, although there is no significant difference. The questionnaire was distributed and filled in by the respondents from various backgrounds. However, this study determined the respondents' backgrounds based on gender, length of work, and school levels of teaching. The results are presented in Table 3.

Three research results, the firstly the measurement of science teachers' digital competence, has revealed that senior high school science teachers have the best dimension of communication and collaboration. Meanwhile, science teachers at all school levels have a less optimal dimension of digital content creation. The information and data literacy dimension at all school levels generally shows good characteristics. Second, the review of the teachers' digital competence shows that the science teachers who have worked for 1-5 years show the best responses to the dimensions of information and data literacy as well as communication and collaboration. The dimension of content creation requires special attention because science teachers who have worked for 6-10 years do not show a maximal response. The science teachers' length of work has shown diverse responses to digital competence. Third, based on the gender factor, female teachers have a lower response to content creation. Meanwhile, male teachers have better reactions to information and data literacy. To conclude, the gender data show that male teachers have more significant responses than female teachers.

**Table 3.**
Percentage of science teachers' competence in terms of gender, length of work, and school levels of teaching

| Digital Competence Dimensions of Teachers | School Levels | | | | Length of Work (Years) | | | Gender | |
|---|---|---|---|---|---|---|---|---|---|
| | Junior high school | Islamic junior high school | Islamic senior high school | Senior high school | 1-5 | 6-10 | > 10 | Male | Female |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Information and data literacy | 84% | 83% | 83% | 91% | 88 % | 80 % | 83 % | 87 % | 84 % |
| Communication and collaboration | 83% | 85% | 85% | 90% | 88 % | 82 % | 83 % | 86 % | 85 % |
| Digital content creation | 76% | 79% | 76% | 81% | 80 % | 68 % | 77 % | 81 % | 77 % |
| Security | 80% | 81% | 77% | 86% | 83 % | 77 % | 79 % | 84 % | 80 % |
| Problem-solving | 77% | 81% | 79% | 85% | 81 % | 75 % | 78 % | 83 % | 78 % |

On the dimensions of information and literacy, data on male teachers who work at the senior high school level have good competence with less than 5 years of service. The dimensions of communication and collaboration of male teachers at the senior high school level have good competence with less than 5 years of service. The dimensions of digital content for male teachers who work at the senior high school level have good competence with a working period of less than 1 year. The security dimension for male teachers working at the senior high school level has good competence with less than 5 years of service. And the dimensions of problem-solving for male teachers who work at the senior high school level have good competence with less than 5 years of service. It can be concluded that male teachers who have worked for less than 5 years at the senior high school level have good digital competence.

### *3.1. Science teachers' gender-based responses to digital competencies*

The gender-based review has shown that science teachers do not have different competence. The statistical test has revealed a significance value of >0.05. This score indicates that science teachers of two genders have equal competence. In addition, the output of the calculated F-value is not greater than the statistically minimal value. The five digital competence dimensions of the teachers were calculated by considering the gender factor. The results signify that genders do not have different scores for information and data literacy, communication and collaboration, digital content creation, security, and problem-solving. The research samples have shown that men and women conceptually and technically have the same understanding and technical skills when working as science teachers. Unfortunately, this finding has not been confirmed by any scientific reasons why they do not show different digital competence.

**Table 4.**
ANOVA outputs of science teachers' digital competence in terms of gender

| | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 126.762 | 1 | 126.762 | 1.458 | .230 |
| Within Groups | 8952.800 | 103 | 86.920 | | |
| Total | 9079.562 | 104 | | | |

The results obtained F = 1.458, with a significance of 0.230. There was no difference in the overall digital competence of teachers. Digital competency scores for teachers based on gender did not experience a significant difference.

### *3.2. Science teachers' responses to digital competencies in terms of school levels*

The school-level-based review has shown that science teachers have different competence. The statistical test has revealed a significance value of <0.05. This score indicates that the science teachers from different

school levels of teaching have dissimilar competence. In addition, the output of the calculated F value is greater than the statistically minimal value.

**Table 5.**

ANOVA outputs of science teachers' digital competence in terms of school levels of teaching

| | Sum of Squares | df | Mean Squares | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 804.906 | 3 | 268.302 | 3.275 | .024 |
| Within Groups | 8274.656 | 101 | 81.927 | | |
| Total | 9079.562 | 104 | | | |

The results obtained were F = 3.275, with a significance of 0.024. There are differences in the overall digital competence of teachers. Teacher digital competency scores based on teaching level factors experience significant differences. The five digital competence dimensions of the teachers were calculated by considering the school levels of teaching. The results show several differences. First, Islamic senior high school teachers have the best communication and collaboration dimension than junior high school teachers. Meanwhile, Islamic senior high school teachers have better communication and collaboration than Islamic junior high school teachers. Finally, senior high school teachers have better communication and collaboration than junior high school teachers.

**Table 6.**

LSD outputs of science teachers' digital competence in terms of school levels of teaching

| (I) School levels | (J) School levels | Mean Difference (I-J) | Std. Errors | Sig. | 95% of Interval Confidence Lower Bound | Upper Bound |
|---|---|---|---|---|---|---|
| Junior high school | Islamic junior high school | -1.92511 | 2.24059 | .392 | -6.3698 | 2.5196 |
| | Senior high school | -7.08511* | 2.33818 | .003 | -11.7234 | -2.4468 |
| | Islamic senior high school | .09671 | 3.03168 | .975 | -5.9173 | 6.1107 |
| Islamic junior high school | Junior high school | 1.92511 | 2.24059 | .392 | -2.5196 | 6.3698 |
| | Senior high school | -5.16000 | 2.64595 | .054 | -10.4089 | .0889 |
| | Islamic senior high school | 2.02182 | 3.27491 | .538 | -4.4747 | 8.5184 |
| Senior high school | Junior high school | 7.08511* | 2.33818 | .003 | 2.4468 | 11.7234 |
| | Islamic junior high school | 5.16000 | 2.64595 | .054 | -.0889 | 10.4089 |
| | Islamic senior high school | 7.18182* | 3.34244 | .034 | .5513 | 13.8123 |
| Islamic senior high school | Junior high school | -.09671 | 3.03168 | .975 | -6.1107 | 5.9173 |
| | Islamic junior high school | -2.02182 | 3.27491 | .538 | -8.5184 | 4.4747 |
| | Senior high school | -7.18182* | 3.34244 | .034 | -13.8123 | -.5513 |

*. The mean difference is significant when it is 0.05.

There are differences in teacher digital competence based on the factor of the teaching level (table 5), so further analysis is carried out. Based on the results in table 6, teachers working at the senior high school level have better competence than teachers working at the junior high school, Islamic junior high school,

and Islamic senior high school levels. This is because the results of the LSD calculation stated a score of 7.18182, which indicated differences in teacher digital competence.

### *3.3. Science teachers' responses to digital competencies in terms of length of services*

The review based on the length of work has shown that the science teachers do not have different competence. The statistical test has revealed a significance value of >0.05. This score indicates that science teachers with various lengths of work have equal competence. In addition, the output of the F-value is not greater than the statistically minimal value.

**Table 7.**
ANOVA outputs of science teachers' digital competence in terms of length of work

| | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 305.650 | 2 | 152.825 | 1.777 | 0.174 |
| Within Groups | 8773.912 | 102 | 86.019 | | |
| Total | 9079.562 | 104 | | | |

Result F = 1.777, with a significance of 0.174. These results indicate that there is no overall difference in teacher digital competency. The teacher's digital competency score based on the work period factor did not experience a difference. The five digital competence dimensions of the science teachers were calculated by considering the length of work. The results show no differences in the dimensions of information and data literacy, communication and collaboration, and security. On the other hand, the teachers who have worked for 1-5 years have better responses to digital content creation and problem-solving than teachers who have worked for more than 10 years.

## 4. Discussion

This study aims to determine science teachers' opinions about their digital competence and reveal differences in gender, school level of teaching, and length of work. The questionnaire of digital competence items of science teachers was analyzed using descriptive statistics. The analysis has revealed that science teachers show high responses to the dimensions of information and data literacy, communication and collaboration, and problem-solving, while their responses to the dimensions of security and digital content creation are low.

Moreover, their security and digital content creation competencies, which uses software to support or develop content ideas, have lower average scores than the other dimensions. This condition probably happens because the teachers have a low intensity of content creation and technical skills. Teachers should more highly consider the dimension of security when accessing the internet for any purpose. Garcia explains that increasing digital security can facilitate and enhance the digital competence levels of teachers (García-Vandewalle García et al., 2021). The fact shows that science teachers have better digital competence in communication and collaboration, information and data literacy, and problem-solving because they have frequently used digital technology in their routines before working as teachers. Therefore, they are familiar with exploring skills to eliminate the possibility of facing problems. On the contrary, they still have a low dimension of digital content. This condition is supported by Blau and Inbal (2017), who state that teachers have relatively low skills in designing digital content. Technology makes digital content creation and development unique and different. However, teachers who rarely use digital content would prefer using teaching materials owned before the pandemic. Teachers should receive training in digital content creation (Røkenes & Krumsvik, 2016).

Science teachers are considered good skills if they can search, separate, and compile new information. The way people get information on the internet is different (Keskin & Yazar, 2015). Users do not show obstacles to applying various communication techniques on the internet and sharing files. The cause of their technical breakdown can be solved quickly by watching video tutorials and reading internet articles. However, a less significant impact arises from digital content creation and security. Security issues should be considered to prevent identity theft or to cyberbully when new technology is not used correctly (García-Vandewalle García et al., 2021). The teachers' skills in developing digital content for student learning are still low. The application of e-learning in MA still has limited facilities and infrastructure (Ghafur, 2021). Learning content cannot be created due to operating or technical limitations. In addition, the teachers still have low awareness of the digital footprint, do not understand the risks of accessing internet content, and do not protect their devices. Although the pandemic has forced the implementation of online learning for two years, many science teachers still have inadequate skills or standardized digital competence.

Regarding the school level, the science teachers show different digital competence. Junior high school teachers have the best digital competence in all measured dimensions, especially literacy skills and information processing, as well as online environment collaboration for communication. This study has revealed that senior high school science teachers are excellent at anticipating security and online footprint to protect the privacy of their digital devices. Moreover, they have the best competence in content creation and problem-solving.

The gender factor in this study shows that the science teachers do not show different digital competence. Moreover, the male and female teachers have similar scores on the five digital competence aspects. The average scores of their communication and collaboration competence are identical, so their skills are relatively the same. However, male teachers have better problem-solving competence than female teachers. This phenomenon is probably caused by a professional category that can improve digital competence, especially in problem-solving competence (Hinojo-Lucena et al., 2019). Conditions for resolving obstacles are essential to success in online learning. However, the teachers' five dimensions of digital competence are not significantly different. Several previous studies have found that male teachers predominantly excel in digital competence more than female teachers (Casillas Martín et al., 2020; Esteve-Mon et al., 2020; Guillén-Gámez et al., 2021). This finding differs from this research because these previous studies applied gender as the differentiating factor from the teachers' digital competence. In reverse, this research does not.

The length of work of science teachers does not show differences in digital competence. The descriptive analysis shows that science teachers have good skills in information and literacy. The teachers who have worked for 1-5 years have better information skills and communication and collaboration competence than those who have worked for 5-10 years. The teachers have a low average score in the digital content creation dimension. The length of work factor has triggered the teachers to perceive that they have inadequate expertise to develop the latest digital content. The result of this study disagrees with that of Hinojo, who has discovered that teachers with more than ten years of teaching experience have better digital competence (Hinojo-Lucena et al., 2019). Teachers' delay in mastering digital content is causeddim by their age; the older the teachers, the lazier they are in self-development (König, Jäger-Biela & Glutsch, 2018).

The factor of school levels of teaching also shows significantly different scores of digital competence. In contrast, the factors of gender and length of work do not. Overall, science teachers, in terms of all factors, have a low aspect of digital content creation. This aspect is identified from several items, such as developing content in a simple form using digital technology, developing content using various technology-assisted formats, paying attention to copyrights and licenses, and modifying existing content.

This study suggests that special measures should be conducted to improve science teachers' digital content creation skills.

## 5. Conclusion

The unique findings of this study try to make up for the shortcomings of previous studies. The study results show that science teachers lack digital competence in security and digital content creation. Still, they have digital competence in information and data literacy, communication and collaboration, and problem-solving. The factors of gender and length of work show that teachers do not have different digital competencies. In contrast, the school level of teaching factor shows that teachers have different digital competencies.

This study has found that high school science teachers have the best digital competencies of all teachers at all school levels. Meanwhile, Islamic junior high school teachers have better digital competence than junior high school teachers. Teachers, in terms of all factors, have low competence in digital content creation; thus, it should be improved.

## 6. Recommendations

The study's results stated that male teachers at the high senior school level have good digital competence. Efforts are needed to align these abilities through improving teacher soft skills supported by the school through workshops, training, and seminar programs. Subsequent research needs to review each dimension of teacher digital competence in detail, and analysis can comprehensively examine the supporting factors to determine the increase in these competencies.

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