

Incidence of Gender in the Teacher's Digital Competence: A Meta-Analysis Study

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Abstract: *These research aims to analyze and compare (differ) the level of teacher's Digital Competence across gender. A meta-analysis systematically examined the related studies in Google Scholar database and highlight the methodological and effect size issues found within the literature. A total of 6 eligible studies were included in the final analysis, including 430.406 teachers. The forest plot, funnel plot, Rank Correlation and Regression Method are used to summarize and visualize the results of multiple studies and conduct subgroup analyses. The finding revealed moderate and positive impact size (random effects model) of $r = 0.23$ with a 95% confidence interval with the digital competency of male teachers is 23% higher than that of female ones.*

Keywords: *Digital Competence, gender, meta-analysis, effect size*

INTRODUCTION

We are currently living in a disruptive period where technology is heavily utilized in many sectors of the economy, including education. Therefore, in this disruptive era, digital literacy competency is considered as being necessary in addition to teacher proficiency for these four (four) competencies. In order to improve learning outcomes and develop human resources with the character to advance education in Indonesia, educators must be knowledgeable about digital literacy (Setiawati et al., 2023).

Studies related to teacher digital competence flourished throughout the years especially after covid-19 hit all over the world. These studies generally empirical researches that aims to track and measure how the level of teacher digital competence varies across demographic characteristics. When the results of these studies are examined, it is observed that the findings are different and inconsistent from one another; hence it is hard to obtain generalizable knowledge. In this regard, meta-analysis studies are at the forefront. This research aims to investigate whether the level of teacher digital competence varies across gender through use of meta-analysis method.

With a view to understanding the significance digital competence of the teacher in 5.0 era, it is essential to scan the definitions made about the concept, the significance, and dimensions of digital competence. Digital competence refers to the proficiency and capability of higher education teachers to effectively utilize Information and Communication Technologies (ICT) resources in their research work. This includes skills related to digital tools, ethical considerations in digital practices, managing digital information, overcoming anxiety towards ICT, assessing the quality of ICT resources, intention to use ICT, and integrating ICT into their teaching and research tasks (Guillén-Gámez et al., 2021). (Gómez-Trigueros & De Aldecoa, 2021) defines Digital Competence as the ability of individuals to use digital technologies effectively and responsibly in various contexts, including education. It encompasses skills related to the use of digital tools, information processing, knowledge creation, and the ethical and safe use of digital resources. According (Rubio-Gragera et al., 2023), digital competence is defined as all the skills, attitudes, and knowledge required of teachers in a digitalized world. It refers to the digital competence related to the use of ICT from a didactic-pedagogical perspective in a professional educational context. While (García-Vandewalle García et al., 2023) states "digital competence" refers to the ability of individuals, particularly educators and teacher trainees, to effectively and responsibly use digital technologies for various purposes, including teaching, learning, communication, and problem-solving. It encompasses skills related to information and data literacy, communication and collaboration, digital content creation, safety and security, problem-solving, and the critical and creative use of ICT.

Digital competence could enhance the communication and collaboration abilities of teachers with students and colleagues. By having a high level of digital competence, teachers can effectively utilize digital resources, facilitate interactions within the educational community, overcome the digital gap, provide equitable education opportunities, ensure that students receive quality instruction, adapt to the evolving educational landscape and meet the diverse needs of students in today's digital age (Guillén-Gámez & Mayorga-Fernández, 2022). (Gómez-Trigueros & De Aldecoa, 2021) emphasizes that by having strong digital competence to effectively integrate technology into their teaching practices, teachers enhance student learning outcomes, and prepare students for the digital demands of the 21st century. Digital competence is essential for higher education teachers to prepare students for the labour market, as teaching characteristics have a significant influence on students' use of digital resources. Additionally, in the context of building knowledge and contributing to the creation of

knowledge, digital competence is crucial for teachers to be active researchers and creators of knowledge (Guillén-Gómez et al., 2021; Guillén-Gómez & Mayorga-Fernández, 2022). Digital competence is crucial for individuals in today's digital age for several reasons: Enhanced Communication, Improved Learning, Professional Development, Increased Efficiency, Global Connectivity, Empowerment, and Innovation, thrived in the digital era, engaged meaningfully in society, and adapted to the evolving technological landscape (Guillén-Gómez & Mayorga-Fernández, 2022). Furthermore (Rubio-Gragera et al., 2023) states by integrating technology into teaching methodologies teachers could enhance student learning experiences. Digital competence enhances education quality, bridge the digital divide, prepare educators to meet the demands of the modern labour market, improve teaching practices, and provide students with the necessary skills for the digital age. Additionally, digital competence is linked to economic and social development, as well as reducing unemployment, poverty, and social exclusion. Strengthening digital competence among educators is crucial for promoting innovation, enhancing employability, and fostering active citizen engagement in the information society (García-Vandewalle García et al., 2023).

(Guillén-Gómez & Mayorga-Fernández, 2022) in their study identified several attributes of digital competence among rural teachers such as Communication Skills, Technology Use, Collaboration, Adaptability, and Pedagogical Approach. Whereas (Guillén-Gómez et al., 2021) examined the dimensions of digital competence examined in the higher education context which provide insights into the digital readiness and capabilities of higher education teachers in conducting research tasks as follow: Digital Skills, Digital Ethics, Digital Flow, Anxiety Towards ICT, Quality of ICT Resources, Intention to Use ICT, and Integration of ICT. (Gómez-Trigueros & De Aldecoa, 2021) discusses various attributes of Digital Competence among teachers, including: Technological Knowledge, Pedagogical Knowledge, Ethical and Safe Use of Resources, Leadership in Technology Use, and Personal Learning Environment (PLE). Moreover (Guillén-Gómez et al., 2023) highlighted the attributes of digital competence that are essential for rural teachers for instance, Communication Skills, Integration of Technology, Use of Digital Resources, Adaptability, and Collaboration. Furthermore (García-Vandewalle García et al., 2023) highlighted the attributes of digital competence include: Information and Data Literacy, Communication and Collaboration, Digital Content Creation, Safety and Security, Problem-Solving, and Critical and Creative Use of ICT.

Numerous studies have been conducted on teacher digital competence towards various variable. The studies have analysed the level of digital competence of 910 university teachers

based on gender, professional category, and areas of knowledge (Sánchez-Caballé & Esteve-Mon, 2022), the Years of Experience (Guillén-Gámez et al., 2022), educational stage between gender (Basgall et al., 2023), between digital immigrant and digital native teachers (Sansosa, I. & Iskandar, 2023). Through synthesizing the research literature, we help educational authorities design teacher professional development related to digital competence.

Upon examining the relevant literature, it has been determined that meta-analysis studies on the digital competencies are limited. A meta-analysis study conducted by (Liesa-Orus et al., 2023) including 31 studies carried out between 2015 and 2021 has only examined whether the level of digital competencies among university lecturers differs across years of teaching experience. The limited number of demographic variables used in a few number of meta-analyses has raised need for conducting such a study. Within this scope, answer of the following question has been sought.

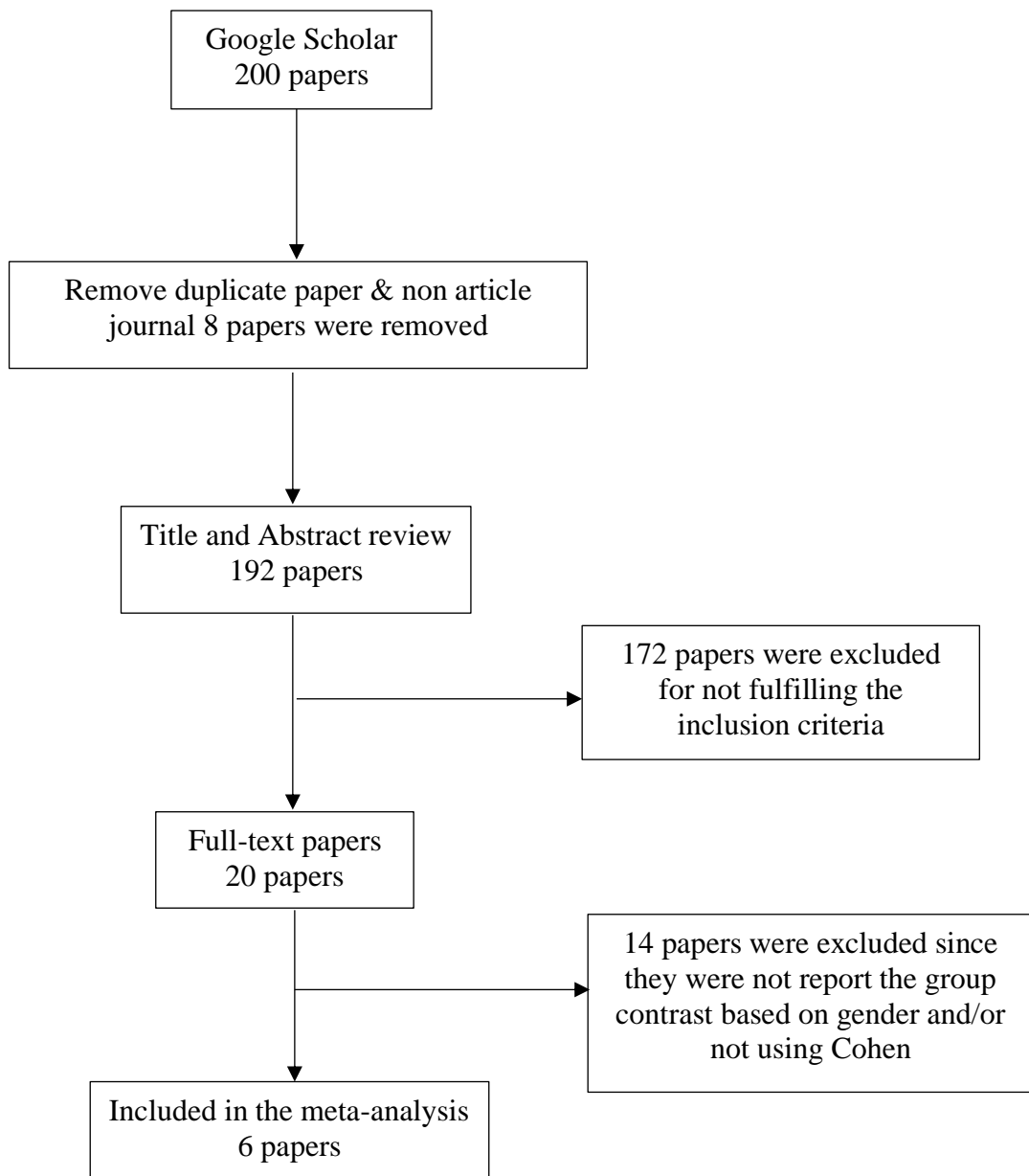
1. Do teacher's digital competences vary across their gender?
2. Is the gender variable a real determining factor in the level of teacher digital competence

RESEARCH METHODOLOGY

Searching and screening the literature for qualifies studies

This research has been designed through use of the meta-analysis method. Meta analysis is systematic, quantitative research that uses previously published studies that have been used by other researchers to draw valid conclusions (Retnawati, H. et.al., 2022). This study has scanned databases from Google Scholar from year 2019 to 2024 in order to explore whether teacher digital competences vary across gender. 200 studies have been achieved through the search using the keywords such as “digital competences”, “teacher education”, and “group contrast”. Using PRISMA diagram of all the studies, those that meet the specific criteria are included in the meta-analysis study. The following criteria have been used in determining the studies to be included in this research: 1) no duplicate paper. 2) title and abstract include variables such as Digital Competence, digital gap, teacher, teacher education, group contrast, quantitative. 3) gender and using Cohen's effect size. 200 studies meeting the first criteria have been included in the study with 8 is removed due to duplication and non-article journal. 20 of 192 studies have been determined according to the second criteria. Lastly, 6 studies have been included in the meta-analysis considering the third criteria referring to the fact that it shows the analysis based on gender and using Cohen's effect size.

Picture 1. PRISMA flowchart of literature review



Sample

The sample used in these studies have been examined. Table 1 presents the number of the studies, their characteristics and sample sizes.

Table 1. Descriptive tables regarding the studies

Studies	Countries	Year	Category	Sample Size
Wuryaningsih	Indonesia	2019	Male	115072
			Female	312117
Noviyanto, I.	Indonesia	2020	Male	4
			Female	11
Guillén-Gámez et al.	Peru	2021	Male	762
			Female	582
Gómez-Trigueros & De Aldecoa	Peru	2021	Male	83
			Female	111
Guillén-Gámez, F. D., & Mayorga-Fernández, M. J.	Peru	2022	Male	266
			Female	581
Guillén-Gámez et al.	Peru	2023	Male	260
			Female	557

Table 1 displays that 6 of the studies include “gender” variable and that the sample of these studies holds a total of 430406 teachers altogether. Of the total sample, 27.05% are male (a total of 116,447) and 72.95% are female (a total of 313,959). Study 1 consists of 266 male teachers and 581 female teachers. Whereas study 2 comprises of 762 male teachers and 582 female teachers. As for study 3 composed of 83 male teachers and 111 female teachers. For study 4 there are 260 male teachers and 557 female teachers. For study 5 consist of 115,072 male teachers and 312,117 female teachers. And there are 4 male teachers and 11 female teachers for the last study.

Table 2. Data base of meta-analysis of teacher’s digital competence based on gender

No	Studies	Year	Male			Female		
			Mean	SD	n ₁	Mean	SD	n ₂
1	Wuryaningsih	2019	58.258	15.378	115,072	59.71	15.124	312,117
2	Noviyanto, I.	2020	75.5	5.92	4	79.85	4.48	11
3	Guillén-Gámez et al.	2021	5.14	0.63	762	5	0.79	582
4	Gómez-Trigueros & De Aldecoa	2021	4.45	0.54	83	2.82	0.70	111
5	Guillén-Gámez, F. D., & Mayorga-Fernández, M. J.	2022	3.52	0.84	266	3.27	0.81	581
6	Guillén-Gámez et al.	2023	3.59	0.84	260	3.26	0.72	557
	Total				116,447			313,959

RESULT FINDINGS

Statistics Analysis

The objective of this meta-analysis is to study the level of teacher digital competence, analysing the influence of moderating variables of gender. Table 3 shows Summary of calculation results.

Table 3. Summary of calculation results

No	Studies	Year	D	S_{within}	d	V_d	SE_d	J	g	V_g	SE_g
1	Wuryaningsih	2019	-1.452	63.155	-0.023	0.034	0.184	1.000	-0.023	0.034	0.184
2	Noviyanto, I.	2020	-4.35	19.187	-0.227	0.026	0.161	0.941	-0.213	0.024	0.156
3	Guillén-Gómez et al.	2021	0.25	0.381	0.656	0.421	0.648	0.999	0.656	0.420	0.648
4	Gómez-Trigueros & De Aldecoa	2021	1.63	1.731	0.941	0.640	0.800	0.996	0.938	0.638	0.799
5	Guillén-Gómez, F. D., & Mayorga-Fernández, M. J.	2022	0.25	0.249	1.005	0.664	0.815	0.999	1.005	0.664	0.815
6	Guillén-Gómez et al.	2023	0.33	0.239	1.381	0.724	0.851	0.999	1.379	0.724	0.851

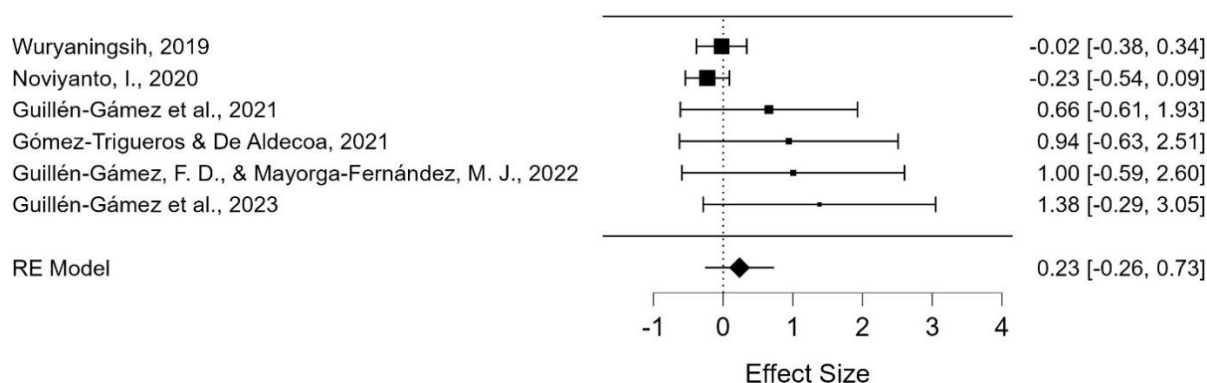
In the execution of this, it was necessary to transform the statistical values of each sample to a Z Fisher measure. Thus, Figure 2 (forest plot) shows a moderate effect size (random effects model) of $r = 0.23$ with a 95% confidence interval $(-0.26, 0.73)$ for the different studies. The summary effect of 0.23 means that the digital competence of male teachers is 23% higher than the digital competence of female teachers. Thus, there are differences in digital competence abilities seen from the gender side.

Other information that can be obtained from the forest plot in the figure is that of the six studies there are four studies that have effect sizes that fall in the interval 0.60 to 1.40, namely research conducted in Peru by Guillén-Gómez, F. D., & Mayorga-Fernández, M. J., Guillén - Gómez, et.al. & Gómez-Trigueros & De Aldecoa. The confidence interval that limits each effect size shows the accuracy of a study. If the confidence interval does not include 0, then the study is statistically significant. The forest plot image indicates that the effect size between one study and another is not very consistent.

Based on the results of the random-effect model calculation analysis using the JASP application, a summary effect of 0.235 was obtained with a 95% confidence interval ranging from -0.256 to 0.725. Because the confidence interval contains 0 (zero), there is strong evidence

that the digital competence of male teachers is not too different from the digital competence of female teachers. This is also reinforced by the results of testing the null hypothesis ($H_0 = 0$) where we have to accept this hypothesis because the Z value of the summary effect is 0.938 with a p-value (0.348) greater than the α value (0.05). If you pay attention to the summary effect value ($M = 0.235$), it shows that the effect magnitude is classified as moderate ($0.20 \leq M \leq 0.80$). The conclusion that can be drawn based on the random-effect model is that there is a slight difference in digital competence in terms of gender.

Picture 2. Forest Plot



The dispersion of values found in Figure 2 (forest plot) indicates a possible heterogeneity of studies. In this way, the heterogeneity statistics of the sample have been studied according to Cochrane in Higgins and Green (see Table 4). More specifically, it is found that the Q statistic of Omnibus test of Model Coefficients ($Q = 0.880$, $df = 1$, $p = 0.348$) and Q statistic of Test of Residual Heterogeneity ($Q = 8.447$, $df = 5$, $p = 0.133$) presents a medium variability. This allows for rejecting the homogeneity hypothesis. The statistic $I^2 = 57.801\%$, which explains the percentage of variability resulting from heterogeneity and not chance. In this case, again, there is moderate heterogeneity.

In terms of coherence, the need to follow a random model or random effects model is ratified. Despite the inclusion of criteria that ensure the quality and reliability of the data through the selection of databases of recognized prestige and journals that apply double blindness, it is considered necessary to carry out an Egger's test with 95% reliability in order to study the effect of bias. This test shows the absence of publication bias with a confidence interval of 95% ($p\text{-value} = 0.005$) (see Table 3). On the other hand, the value of the standard error is not high ($SEI = 2.808$), indicating proximity to the regression line and reaffirming the absence of publication bias (Retnawati et al., 2022). This research used Funnel plot and Rank Correlation and Regression Method to test the publication bias. Figure 1 presents The Funnel

Plots and table 2 and 3 present Rank Correlation and Regression Method showing the publication bias.

Table 4. Heterogeneity Statistics

Fixed and Random Effects

	Q	df	p
Omnibus test of Model Coefficients	0.880	1	0.348
Test of Residual Heterogeneity	8.447	5	0.133

Note. *p* -values are approximate.

Note. The model was estimated using Restricted ML method.

Coefficients

	Estimate	Standard Error	z	p	95% Confidence Interval	
					Lower	Upper
intercept	0.235	0.250	0.938	0.348	-0.256	0.725

Note. Wald test.

Residual Heterogeneity Estimates

	Estimate	95% Confidence Interval	
		Lower	Upper
τ^2	0.158	0.000	2.061
τ	0.398	0.000	1.435
I^2 (%)	57.801	0.000	94.691
H^2	2.370	1.000	18.837

Parameter Covariances

intercept	
intercept	0.063

Rank correlation test for Funnel plot asymmetry

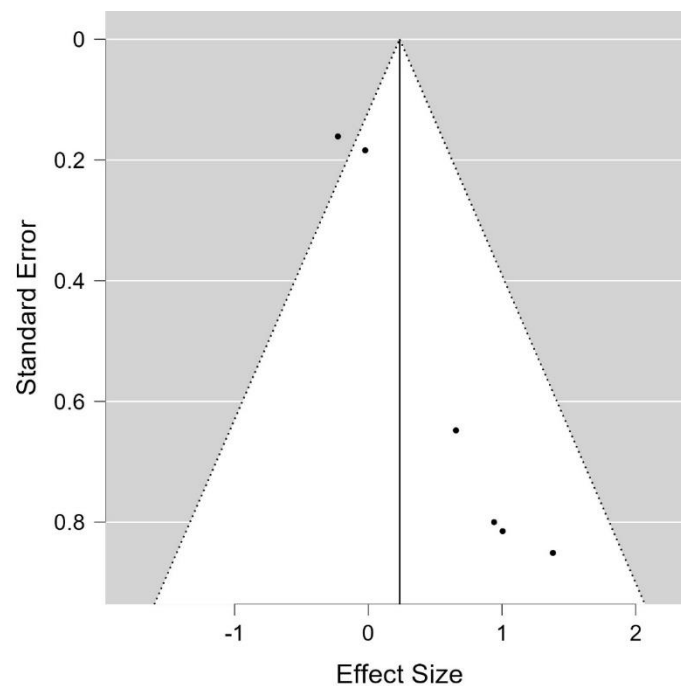
	Kendall's τ	p
Rank test	1.000	0.003

Regression test for Funnel plot asymmetry ("Egger's test")

	z	p
sei	2.808	0.005

The variability evidenced in the statistics $Q = 8.447$ and $I^2 = 57.801\%$ (see Table 4) is indicative of average data, despite presenting an adjusted confidence interval $(-0.256 \ 0.725)$. These data are consistent with the funnel plot graph (Figure 3) where the variability found previously is reaffirmed. This situation reiterates the quite diversity of studies; as the Egger test concludes (Table 3), there is a moderate degree of heterogeneity within the nature of the studies themselves. This shows the need to carry out model comparison analyses and meta-regressions that can explain the origin of this diversity.

Picture 3. Funnel Plots



DISCUSSION & CONCLUSION

All six studies related to teacher digital competence use questionnaire likely includes items that capture various aspects of digital competence. By utilizing this questionnaire, the researchers were able to gather data on teachers' digital competence levels and analyze how gender influences their proficiency in digital skills. The questionnaire serves as a valuable tool for assessing and understanding the digital competence in the context of educational interactions.

In the study by (Guillén-Gámez & Mayorga-Fernández, 2022) the result highlights gender differences in the level of development of teachers' overall digital competence. Female teachers who use a battery of digital resources for communication with the educational community tend to have higher scores compared to those who do not use these resources. Significant differences were observed in the use of various digital platforms. As for the results of the study (Guillén-Gámez et al., 2021) on Digital Competence among higher education teachers shows overall, there were no significant differences in the level of digital competence between genders among the sample of teachers. However, this study highlighted significant differences in the perception and practices of male and female teachers in various dimensions of digital competence: These results underscored the existence of a digital gender gap in teacher education, with male teachers exhibiting higher levels of digital competence and leadership in technology integration compared to their female counterparts. Addressing these disparities is crucial for promoting equal access to and effective use of digital technologies in education.

The results of the study (Gómez-Trigueros & De Aldecoa, 2021) on Digital Competence among teachers highlighted significant differences in the perception and practices of male and female teachers in various dimensions of digital competence. These results underscored the existence of a digital gender gap in teacher education, with male teachers exhibiting higher levels of digital competence and leadership in technology integration compared to their female counterparts. Addressing these disparities is crucial for promoting equal access to and effective use of digital technologies in education. The results of the study (Guillén-Gámez et al., 2023) on digital competence among rural teachers is that Gender and teaching specialty were significant predictors in the communication that teachers had with various stakeholders in the educational community, including students, teaching teams, and families. The results of the study provide insights into the digital competence of rural teachers in primary education, emphasizing the importance of gender, teaching specialty, and the effective use of digital

resources in enhancing teachers' proficiency in utilizing technology for educational purposes and engaging with the educational community.

For the study of (Wuryaningsih et al., 2019) compared the impact of web-based learning and face-to-face learning on teachers' achievement in teacher training programs. The study found statistically significant differences between the online/blended learning model and the face-to-face method in terms of teacher achievement. Additionally, the research highlighted that female teachers tended to perform better than male teachers in web-based learning (online and blended learning).

The Relationship of Gender and Length of Work with the TPACK Competencies Of SMA/MA Chemistry Teachers are learned in Indonesia (Noviyanto, 2020). There is a relationship between gender and the chemistry teacher's TPACK competency. In addition, according to correlation test between the length of service variable and the TPACK competency of chemistry teachers there is a relationship between length of service and the TPACK competency of chemistry teachers. The research results show that there is a positive relationship between gender, length of service and TPACK competency. Apart from that, female chemistry teachers have better TPACK competency ($79.85 > 75.5$). Furthermore, chemistry teachers with a service period of ≥ 10 years have better TPACK competency compared to teachers with a service period of < 10 years ($79.3 > 77$).

Based on the statistical calculation represented in Figure 2's forest plot displays a moderate and positive impact size (random effects model) of $r = 0.23$ with a 95% confidence interval. In conclusion the digital competency of male instructors is 23% higher than that of female teachers, according to the aggregate impact of 0.23. As a result, there exist gender-based disparities in digital competency abilities. The result of the study quite different with (Qazi et al., 2022) which investigates how gender differs in ICT use and technological learning skills from a thorough search of eight journal databases conducted along with a particular selection criterion that is 42 peer-reviewed empirical articles and conference proceedings that were released between 2006 and 2020. Their small-scale meta-analysis for a subsample of research in order to measure potential gender disparities in ICT use and proficiency indicate a tiny, positive, but non-significant effect size favoring boys was found using a random-effects model ($g = 0.17$, 95% CI $[-0.01, 0.36]$). Therefore, more extensive meta-analyses with larger study populations and a wider range of ICT use and skill measures are required to support this finding. In addition another different findings found in the study of (Liesa-Orus et al., 2023) which examined the self-perceived digital competence of university lecturers in teaching utilizing

7470 lecturers with 6–15 years of teaching experience from Europe and Latin America, gathered in $K = 31$ samples. The low skill level is confirmed by the effect size, which is significant, negative, and moderate ($r = -0.21$ with a 99% confidence interval) derived from a moderate random effects model. The findings of the meta-regression indicate that the field of knowledge is significant. This study reveals that although there is a low level of competency and issues with institutional and training support, there is a good perception of ICTs overall.

There are certain restrictions on this meta-analysis. First off, since its sample is restricted to people in Peru, Latin America and Indonesia, Southeast Asia, it begs the question, "What is the reality in Australia, Africa, Europe, or North America?" For this reason, doing international research is essential in order to approach the topic of digital competency from a wider angle. However, as information about digital competency is still developing, the theoretical framework for its application and measurement needs to be reviewed and updated. Furthermore, questions about whether the COVID-19 epidemic has impacted our level of digital competency or whether it has improved it have also been raised. Has the pandemic strengthened the case for online learning? Therefore, in order to determine how teachers' digital competence has impacted education, it will be required to evaluate it before, during, and after in the years to come.

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