



The Use of Information and Communication Technology in Mathematics Education: Does Gender Make a Difference?

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ABSTRACT

Gender equality is a global trend that is a matter for discussion, including in mathematics learning. The ability to use gender-based technology is fundamental to improving the quality of learning. This research aims to describe differences in ICT use strategies by mathematics teachers and differences in students' technology use skills based on gender in mathematics learning. This research is qualitative research with a literature study approach. The indicators for mathematics teachers are viewed from the aspects of the teacher's level of knowledge of ICT, use of technology per hour per day and attitude. Meanwhile, the differences in the ability of male and female students to utilize ICT in learning mathematics can be noticed from the aspects of perception, students' experience and attitudes. The results of the discussion show that mathematics teachers in Indonesia tend to use technology not constructively or only as a learning tool. Female teachers have better strategies or approaches to teaching the integration of technology in mathematics learning while male teachers are more proficient in using or operating digital tools. On the other hand, male students' skills in using technology are better than female students. However, female students can also have the same abilities as males if they have a positive view of integrating technology into mathematics learning.

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INTRODUCTION

One of the signs of God's greatness is the creation of men and women on earth. The existence of gender shows that men and women have unique characteristics with their respective advantages and disadvantages. Therefore, gender differences are seen not as a limitation or obstacle to progress. Every woman and man also gets the same rights in education. Thus, teachers are required to know the right strategy or method for learning in the classroom by

understanding the perspective of how female and male students receive material in the learning process.

One important factor in current educational development is the use of Information and Communication Technology (ICT) in classroom learning. Education plays a role in improving teaching skills by utilizing digital resource tools. Technology integration is also carried out in various subjects. Indonesia, as a country that is still developing, continues to improve education as a provider of technological facilities to support school learning. The teacher's ability to integrate technology is determining in improving the quality of learning. However, there are still many teachers who experience difficulties in operating digital tools. This is revealed from the following data senior female teachers mentioned that they still have difficulty and are rather slow in implementing ICT for teaching English due to internal and external factors (Jamil et al., 2023).

Other subjects such as mathematics also continue to progress following developments in the existing curriculum. One of them is characterized by the integration of technology. The use of ICT in the context of mathematics learning offers the potential to increase student engagement, facilitate understanding of concepts and stimulate motivation to learn mathematics. In other words, one of the innovations carried out by mathematics teachers in the classroom is using technology-based learning. The use of technology in mathematics learning is still very limited. This is in line with the opinion of Perienen (2020) who states that only a minority was using technology in their teaching practices. Teachers renewed the need to be thoroughly trained in the pedagogical integration of Information and Communication Technology (ICT), insisted on the provision of better computer services in schools, including access to the Internet and solicited the support of parents to accompany their children in their studies (Perienen, 2020)

Mailizar (2020) states that the proficiency of a teacher in using technology is enhanced by their knowledge. Factors like gender, educational background, and teaching experience significantly influence the integration of technology in mathematics classes (Mailizar & Fan, 2020). However, it was also found that most of the teachers did not use the technology in constructive ways. The results also revealed that female teachers have better instructional practices in the use of digital technology than male teachers. In other words, gender influences the integration of technology in mathematics learning. It is common knowledge that brain structures of men and women have differences in the anatomical aspects, physical (size), and way of thinking, including learning.

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A limited number of studies have investigated the integration of technologies in mathematics learning in Indonesia. Most of them are part of international studies. Previous studies have used various frameworks and approaches to understand teachers' use of technologies. The results of other research show that the level of ICT knowledge and implementation of SMA/MA mathematics teachers is in the low category and the level of ICT skills is in the medium category (Ana Rasyidah et al., 2015). Therefore, research related to integrating technology in mathematics learning needs to continue to be carried out.

In reality, efforts to integrate ICT in mathematics learning are not always evenly distributed among students based on gender. There may be differences in the level of acceptance, participation, and benefits that male and female students obtain from the use of ICT in the context of mathematics learning. Factors such as learning preferences, level of technology accessibility, and perceptions of ICT effectiveness may contribute to these differences. Research shows that the use of a STEM-based virtual lab with the theme of water pollution is effective in increasing scientific literacy with there being a difference in the results of increasing scientific literacy for female class students (7B) by 0.46 and male class (7D) by 0.29. In other words, the increase in scientific literacy of female students is superior to that of male students after integrating technology into learning (Ismail et al., 2016).

On the other hand, the reasoning of female and male students tends to be different. Male students use more flexible solutions than females. Meanwhile, in concluding, female students are more careful and thorough and are skilled in communicating the ideas they obtain (Firmanti, 2017). Meanwhile, in terms of problem-solving abilities, male students scored significantly higher (76.10) than female students (60.32) (Fitriani et al., 2015). This can affect their ability to use ICT. The use of information and communication technologies (ICTs) in the process of learning mathematics affects gender distinctions by affecting the low rate of matriculation of women into technological studies (Palomares-Ruiz et al., 2020). How students will react to the use of technology in mathematics education can be seen from: General confidence in mathematics; general confidence with computer use; and general confidence in using computers to learn mathematics (Fogarty et al., 2001).

Based on the description above, understanding the impact of using ICT in mathematics education by considering gender differences is an urgent need. This research was initiated to explore more deeply the differences in the use of

ICT by teachers and students in mathematics learning in terms of gender. It is hoped that the research results will provide valuable insight for the development of more inclusive and effective learning strategies in mathematics education environments, taking into account gender diversity.

RESEARCH METHOD

In this study, the approach used was a qualitative research approach. This approach is chosen because it allows the researcher to investigate complex and multifaceted phenomena in their natural setting. The aim of the study is to review the literature published in some academic resources. To achieve the aim of this study, content analysis method was employed. The data collection techniques used in this study were library research techniques. Library research involves the systematic review and analysis of existing literature on a particular topic. This method is useful for gathering information about the phenomenon under investigation, and for identifying existing gaps or areas of disagreement in the literature. The researcher conducted a thorough review of academic articles, books, and other relevant literature in order to gather a broad understanding of the phenomenon and to identify any relevant themes or patterns.

RESULTS AND DISCUSSION

The ICT used by teachers in teaching mathematics in Indonesia can vary, including mobile devices, computers, presentation software, mathematical software, online resources, and others. Moreover, based on the data given, teachers about their experiences in using mobile devices for mathematics instruction. The survey revealed that only 31.9% (68) of the teachers used mobile devices in teaching and learning activities. They used mobile learning in all sorts of activities either indoors (28, or 13.1%) or outdoors (19, or 8.9%) as well as in either formal (24, or 11.3%) or informal (3, or 1.4%) settings (Abidin et al., 2017). Meanwhile, the use of mathematical software is dominated by geogebra (Lainufar et al., 2021)(Lainufar et al., 2021) (Mushlihuddin et al., 2020) which can accommodate students to study algebra, geometry and statistics. Based on initial findings, the number of articles discussing the integration of technology in mathematics learning in terms of gender is very limited. This shows that there is not much research discussing this matter and requires further analysis. The results of the discussion will be analyzed and reviewed based on two aspects, namely from the teacher and student side:

The use of ICT by mathematics teachers by gender

The number of female mathematics teachers in Indonesia is greater than male teachers. The results of research conducted by Mailizar on teachers from 93 schools from 16 different regions in Indonesia in 2021 revealed that female teachers have better instructional practices in the use of digital technology than male teachers (Mailizar & Fan, 2020). On the other hand, research on teachers in West Java (2021) shows differences in the ability to use computers, smartphones and the internet between male and female teachers. Male teachers are better than female teachers; (Supianti et al., 2021). This shows that in terms of the method or approach used to integrate technology, female mathematics teachers are better than male teachers. However, in terms of ability or operating technological tools, male teachers are more dominant.

Based on existing references it was also found that most of the teachers did not use the technology in constructive ways. Teachers commonly use technologies when they teach mathematics topics in traditional ways. In general, female and male mathematics teachers tend to be enthusiastic about participating in training and professional development regarding the use of educational technology. To make it clearer, the trend of differences between teachers' skills in utilizing digital resources in terms of gender can be seen from aspects including teachers' levels of knowledge on ICT, technology use per day and attitudes

Teachers' levels of knowledge on ICT

Based on research conducted on mathematics teachers in West Java in 2021, it was found that the average teacher's ability in the good category was very high, almost all of which were above 80% (Supianti et al., 2021). This shows that teachers are starting to become familiar with existing technological developments and online learning due to Covid-19 several years ago. In addition, the common view is that technology-related activities have been seen as a male domain. Male teachers have good ICT knowledge. However, the present study agrees with those studies as it suggested that female mathematics teachers' instructional practices with digital technology were better male teachers.

Technology use per hour each day

Men and women may have slightly different approaches or ways of using technology in their personal lives. This possibility will influence the way they integrate technology into mathematics learning. Some teachers tend to prefer traditional approaches while others are more open to technology for learning. The length of time interacting with technological tools will affect our skills in using the technology. In Indonesia, the activities of female teachers of

productive age are classified as having many responsibilities including children and family, thus making them interact less with technological tools. In Sidney, males on average work with computers for significantly more hours per week than females (Markauskaite, 2006)

Attitudes

Differences in levels of comfort and confidence in technology may exist between male and female teachers. Teachers who feel more comfortable and confident in using technology are more likely to integrate it into mathematics learning. Based on the research (in Turkey), male teachers had higher scores than female teachers in terms of knowledge and usage. They had more positive attitudes than female teachers did (Tezci, 2010). There are differences in teachers' perceptions of the value of technology in mathematics learning. Attitudes towards technology, which can be influenced by personal factors may also play a role.

Based on the description above, in general male and female teachers have started to integrate technology to support mathematics learning in the classroom. However, based on several studies, it is still done in the traditional or student-centered way. The skills of female teachers are considered better in using technology-based mathematics learning methods compared to male teachers even though male teachers have better skills in using or operating technological tools.

Students' ability to utilize ICT in mathematics learning based on gender

Research regarding students' ability to utilize ICT in mathematics learning based on gender in Indonesia is still very limited. Therefore, the data was analyzed based on existing data, including looking at research from several other countries. Culture or social norms influence the way students, both female and male, engage in the use of technology. One effort that can be made to overcome gender stereotypes is to encourage all students to feel comfortable with technology that can support the development of their skills. Several research results show differences in the abilities of female and male students regarding the use of technology. In Italian secondary school students, the ICT-maths performance association is weaker for girls (Meggiolaro, 2018). To make it clearer, the trend of differences between students' abilities in utilizing ICT for mathematics learning in terms of gender can be seen from aspects including motivation & perception, students' experience and attitudes

Perception

Several studies show that students' perceptions of computers integrated into mathematics learning have a strong relationship with their views on the use of technology in learning. This will also affect their skills in using ICT.

Students who have a positive view of the use of technology in learning may be more motivated to explore digital tools in the context of mathematics learning.

According to Vale, C and Leder GC, in research conducted on school students in Melbourne, male and female students thought differently about the value of computers in their mathematics lesson. Female students' views of computer-based learning are less favorable than male students. In mathematics learning, boys tend to believe that computers contribute to their enjoyment and make the subject more relevant to them. Girls typically worry more about whether computers facilitate learning and enable success in mathematics (Vale & Leder, 2004).

Students' experience

Students' personal experiences with technology have an impact on their skills. Students who are used to using technology in everyday life may adapt more quickly to the use of ICT in mathematics learning. Each student also has a different and unique learning style. Existing data shows that parents believe that boys are more likely to have talent and interest in mathematics. In contrast, girls are considered more anxious but they are hard workers and must practice to master mathematics (Glynn, 2019).

Some students may prefer learning that involves technology, while others may feel more comfortable with traditional learning methods. Boys enjoy learning with patterns that are able to build imaginary structures of concepts in their minds through practicums, hands-on activities, making object designs (Amin, 2018). Of course, this activity is closely related to the use of technology in learning. This is in line with research stated that girls persist with conventional methods instead of using technology (Vale & Leder, 2004). Female students prefer to use pen, paper, ruler or manual tools in learning mathematics. In other words, male students are more familiar with the use of technology and are more confident.

Attitudes

Basically there is no significant difference in the enjoyment of female and male students in using computers. In accordance with research which stated that students' enjoyment of using computers in learning in Gaborone city (Botswana) on the average, many students of both sexes enjoyed computers and the analysis showed no significant differences of enjoyment among sexes at 0.05 levels. However, some reasons were hunted from girls who said not at all enjoy learning using computers. Usually this is because they hate computer classes, don't know much about computers and the teacher is the only one who knows most about computers. However, Boys expressed more positive attitudes toward the use of technology in mathematics, in comparison to girls. On the

contrary, the number of girls expressed dissatisfaction with the way technology was employed in their mathematics classes (Abidin et al., 2018).

Based on the description above, it can be concluded that male students' computer skills are better than female students. This is in line with research conducted by Meredyth et al (1999) which states that students from schools only for boys are single gender; have more advanced computer skills than students at all-girls schools. Although basically female students can also have the same computer skills as boys if they have a positive view of the integration of technology in mathematics learning. As in this research data, in the pretest and posttest, women's marks were better than those of men (Palomares-Ruiz et al., 2020). Moreover, a much earlier study found that females improved their performance relative to males, when using a graphing calculator (Dunham, 2001).

The use of technology in mathematics learning by female and male teachers is limited as a tool to assist the learning process. In other words, the integrated technology has not been able to construct students' knowledge mathematically. These indicate that there is a wide gap between the beliefs teachers hold and the way they actually use ICT. The proposed activities are mostly aimed at one-way content delivery. This causes students not to develop too much and does not really change the traditional way of teaching. Even though ICT aims to foster student motivation and make learning more student-centered (Carlos & Juan Ignacio, 2016). In addition, technology should provide the tools for teachers to connect mathematical theories with the real word problems so that their students are able to explore mathematical concepts and analyze situations as they are problem solving (Sawaya & Putnam, 2015). Therefore, it is hoped that in the future, mathematics teachers, both female and male, can increase their competence to teach technology mathematically in constructing their students' knowledge.

Teachers' skills in using technology are influenced by gender and other factors such as the availability and accessibility of technology. Female teachers have better instructional practices in the use of digital technology than male teachers (Mailizar & Fan, 2020). This is in accordance with data which found that female teachers were more active during the implementation of learning compared to male teachers. Apart from that, the pedagogical content knowledge of mathematics teachers appears to be superior to female teachers compared to male teachers (Diana & Mampouw, 2019). These factors influence the effectiveness of mathematics teachers in integrating technology into the learning process. Moreover, teachers' education level as a crucial factor to improve teacher quality (Mailizar & Fan, 2020). Therefore, the government can

provide training to teachers and provide access to the required technological infrastructure so that they can use technology more often in mathematics classes which makes students more accustomed to it.

Furthermore, differences in students' abilities in using technology in mathematics learning tend to be different between female and male students. Teachers must be wise in choosing their approach when using technology in mathematics learning. Female students tend to be more anxious about using technology because they are more comfortable using conventional learning with ordinary writing tools. However, at the student level, there is no significant difference between the 21st-century skills of female and male students (Zamista & Charona, 2023).

In addition, one alternative that can be done early on to eliminate the gender gap in the learning process is to implement STEAM (Science, Technology, Engineering, Art & Mathematics). This method is good practice for constructing gender equality in early childhood (Rini et al., 2022). The use of technology can be utilized as a tool for gender equality. For example, it can be seen in STEAM activities playing at the natural materials center. There are activities that teachers deliberately provide to build gender naturally through play activities such as washing dishes, grating carrot skin and making carrot juice. This activity is an activity that can be done by both male and female students.

CONCLUSION

The majority of teachers did not use technology in constructive ways. In general, the Indonesian secondary school mathematics teachers dominantly used presentation-oriented tools such as power point. However, it does not provide many advantages in teaching of mathematics. The ability of teachers to integrate technology in mathematics learning can be overcome by following appropriate teacher training programs which help teachers to improve their technology skills and to manifest pedagogical knowledge.

It is common knowledge that the use of Information and Communication Technology (ICT) in mathematics education has a positive impact. However, an interesting insight emerges when considering gender differences. Although existing data show an overall increase in performance, there appears to be variation in the effects of ICT depending on gender. Female teachers tend to experience more significant increases in integrating technology in mathematics learning compared to male teachers.

Secondly, students' skills in using technology are personal and develop over time with learning experiences. Male and female students think differently

about the value of computers in their mathematics lessons. Boys showed more positive attitudes toward the use of technology in mathematics, in comparison to girls. This considers the importance of gender factors in designing teaching strategies and developing an ICT-based mathematics curriculum. One of the keys to achieving equality in mathematics achievement is to encourage active participation and empowerment of both female and male students through technology-based approaches. Teachers or schools play an important role in providing support and resources to improve skills in using technology fairly. All students should engage in the use of ICT to ensure their potential to learn mathematics effectively is enhanced.

Overall, Indonesia as a developing country is still very limited in the use of technology and related research. Therefore, this paper contributes to increasing insight regarding the integration of technology in mathematics learning in Indonesia. In the future, this research can be carried out quantitatively using existing data in the field. The practical implications of the results of this review indicate that educators and policy makers need to pay attention to the dynamics in implementing ICT in the context of mathematics education to achieve more inclusive and sustainable results.

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