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Integration of Digital Technology in the Learning Process Through Problem-Based Learning Models

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ABSTRACT

Digital technology is what most affects the education system today because of the aspects of effectiveness, efficiency, and attractiveness offered. The research approach used in this study was a quantitative research design. This study explores the integration of digital technology in students through quantitative data and enriches the data with qualitative analysis. The samples of this study were students of the education faculty majoring in elementary education at a university in Halu Oleo who were selected through convenience sampling. The first phase of the research is to conduct a problem-solving-based lecture process and then be given a standard scale and open-ended questions. Then the second phase, students are given a questionnaire given through a Google Form, which is sent along with all the information and an invitation to participate. The results of the study show the provision of digital technology-based learning content, especially in the problem-solving process, should consider quality, meaningful, and user-friendly materials. including spreadsheet applications, graphics processing; multimedia arrangements; mind/concept mapping; digital video processing; online class management, and online publishing; and the main reason for the inability to complete tasks is dominated by unsupported smart devices; inadequate programs or applications (software); inadequate internet connection; and the ability to operate the application is not supported.

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1. INTRODUCTION

Professional development goals in all areas must be established early before one begins teaching since elementary school teacher education students are aspiring educators ready to work as professionals in elementary schools. The use of technology as a means of enhancing problem-solving skills, particularly in the area of mathematics, is one that is highly significant. The primary focus of this study is the problem-solving trait, which is a crucial component of 21st-century mathematics teaching and learning. Electronic tools and applications that assist in the delivery of educational information and in the facilitation of the learning process are referred to as a pedagogical strategy to support the development of early math abilities (Cheung & Slavin, 2010). Also, meta-analyses highlight the effectiveness of technology in primary and secondary mathematics education (Li & Ma, 2010; Young, 2017).

Along with the aforementioned, 21st-century learning emphasizes additional crucial qualities in determining 21st-century teaching and learning skills, such as creativity, innovation, critical thinking, problem-solving, communication, collaboration, personal responsibility, global awareness, social skills/cross-cultural competence, team learning, and strict mastery of academic content. This quality must be consistent with recent technology advancements. The contemporary Industrial Era 4.0 has changed and had an impact on many facets of human life, including education. Digital technology, according to Weigand (2010), is what has the biggest impact on the global education system right now. This is a result of the benefits that digital technology-based learning offers in terms of effectiveness, efficiency, and appeal. If fake concrete things dominated their use as a tool for abstract concept representation in the 1980s, digital technology-based visualization is now extensively employed as a tool that is more efficient, effective, interactive, and appealing.

Many of the issues mentioned in the preceding section can be resolved through the use of digital technology in education, which also provides students with a variety of opportunities to engage with and build their mathematical knowledge as well as to embed it in real-world situations and give it meaning (Sacristan et al., 2009). Modern technologies, in addition to their computer power, can enhance collaboration and place a greater emphasis on the practical application of mathematics by modeling, visualizing, manipulating, and recognizing more complicated scenarios. Aspects of mathematics education are evolving as a result of the usage of digital technology, and this view that problem-solving and inquiry should be at the heart of academic topics rather than rote memorization of lists of facts and processes is growing. The availability of digital technology promotes the creation of a collaborative and exploratory classroom and can support students' efforts to conduct independent research and the environment in math classes (Geiger et al., 2010). Computer-based digital technologies enable engagement with or about information, provide domain-specific content, and help teachers and students during such interactions, according to Drijvers (2015). This wide term covers both computer-supported collaborative learning systems and the use of computers for presentations. Although having access to digital technology can be considered a precondition for using it in the classroom, this does not ensure that it will be used in a way that would promote student learning. According to PISA 2018 statistics, there is a link between students' performance and their access to digital devices and the Internet (OECD, 2020). Teachers in the 2013 ICILS research also stated that they used digital technology more frequently when there were less resource restrictions (Fraillon et al., 2014).

The PISA problem-solving framework, which focuses on individual problem-solving, is immediately included in the test's problem-solving procedures (or competencies). (A) Exploring and comprehending are two of the four cognitive processes. This includes understanding any knowledge learned from investigation and involvement with the problem, as well as any information discovered initially about the problem; (B) Representing and formulating. Selected, arranged, and combined with past knowledge is information. Identifies pertinent techniques and practices, as well as methods for resolving issues on a global scale. It is possible to use charts, tables, formulas, symbolic representations, and other artifacts; (C) planning and execution. This includes determining the problem objectives, establishing sub-goals, creating plans to reach target states, and implementing the plan. The strategy could entail taking physical action, interacting with others, and communicating; (D) monitoring, and reflecting. This entails keeping an eye on the actions taken in the plan to reach the desired state, recording progress, and considering the effectiveness of any found solutions (Greiff et al., 2014).

A systems mindset has emerged as a mark of professionalism in practically all occupations, including those in education, as a result of the advancement of technology and the digital world (Redmond &

Macfadyen, 2020). According to the TPACK model, a variety of forms of knowledge are thought to be essential for using technology in the classroom effectively. Knowledge of pedagogical content, such as knowledge of instructional strategies in mathematics education, knowledge of technological content, such as knowledge of specific technologies used in mathematics education, knowledge of pedagogical knowledge of technology, such as knowledge of the effective use of technology in pedagogical situations, and knowledge of technological pedagogical content, such as knowledge of the effective integration of technology. The context of integrating digital technology in learning is a very important aspect of the process of improving problem-solving abilities. Besides that, dependence on technology for future work and learning is becoming increasingly important. This is because modern innovations are becoming more user-oriented, and technology has expanded the possibilities of collaboration, eliminated the problem of distance, and offered computer-based processing functions. Technology integration enables greater collaboration through social media and other online programs.

Focusing on solving problems for students, especially prospective elementary school teachers, will trigger an increase in higher-order thinking that is needed by every student to solve every problem, both in class, school and in the community. Learning in higher education must be able to provide a stimulus so that students can optimize their critical thinking skills. Students use their knowledge to solve a problem in the form of daily life problems, contextual through the help of lecturers so that students can gain new knowledge on their own. In this context, digital technology is a very helpful aspect for students in solving problems. Thus, the application of digital technology in learning. The description above provides an argument for the importance of digital technology, so this research is focused on exploring the integration of digital technology in improving student problem-solving abilities.

In conclusion, the integration of digital technology in the learning process through problem-based learning models has emerged as a promising approach to enhance student engagement, critical thinking skills, and overall learning outcomes. By leveraging the power of digital tools and resources, educators can create dynamic and interactive learning environments where students actively participate in solving real-world problems. This article aims to explore the benefits, challenges, and best practices associated with integrating digital technology into problem-based learning. By examining relevant research and sharing practical examples, we hope to inspire educators to embrace this innovative approach and unlock the full potential of digital technology in transforming the learning experience for students.

2. METHODS

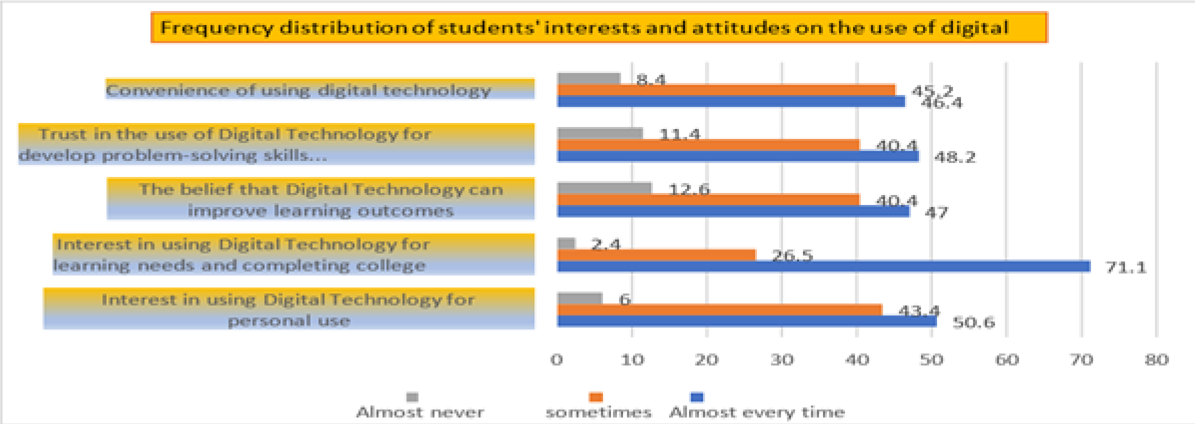
The sample of this study were students of the elementary teachers' education program at a university in Halu Oleo who were selected through convenience sampling and were programming the lecture Mathematical Problem Solving. This study uses a mixed-method research design to explore the integration of digital technology in students through quantitative data and enrich the data with qualitative analysis. The research was conducted in two stages. In the first phase, the lecture process is based on problem-solving. The name of the mathematical problem-solving course held in the even semester of 2021. During college, students are free to use digital technology according to their individual needs. After completing the lecture, the researcher carried out the process of analyzing data from all the assignments given. In the second stage, selected students were invited via WhatsApp or email to fill out a questionnaire. They are also informed that their data and information will be kept confidential, that their participation is voluntary, and that they can withdraw at any time.

The questionnaire was provided via a Google Form, which was submitted along with all information and an invitation to participate. It will take 15 to 20 minutes to complete the questionnaire. Data were analyzed using descriptive statistical analysis and the data collection process was carried out by juxtaposing the results of assignments during lectures with answers in questionnaires.

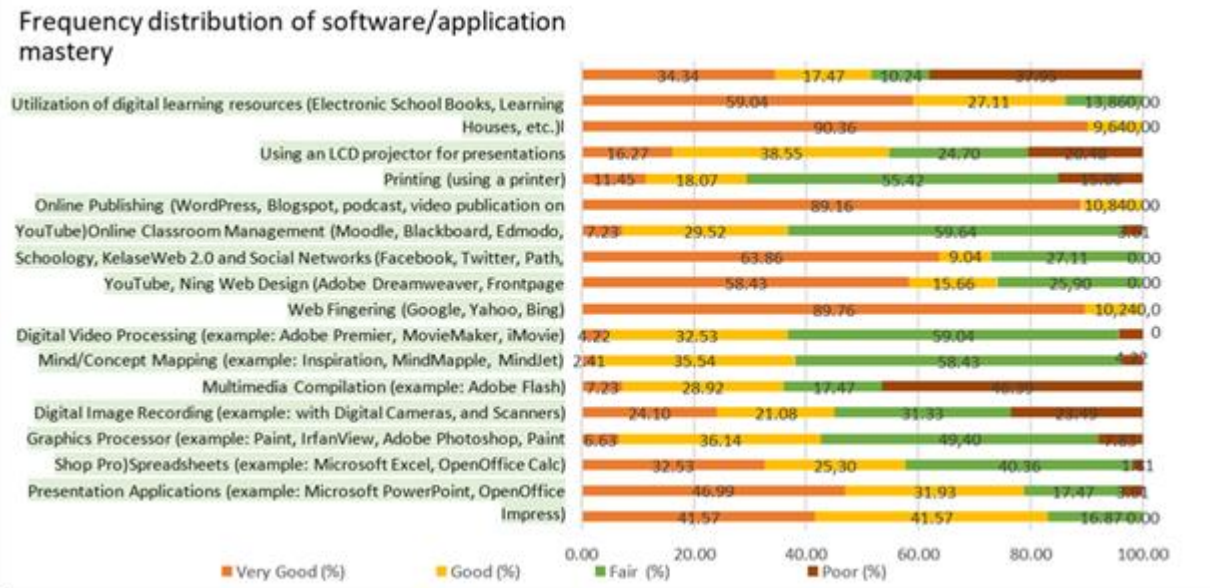
3. FINDINGS AND DISCUSSION

3.1. *Findings*

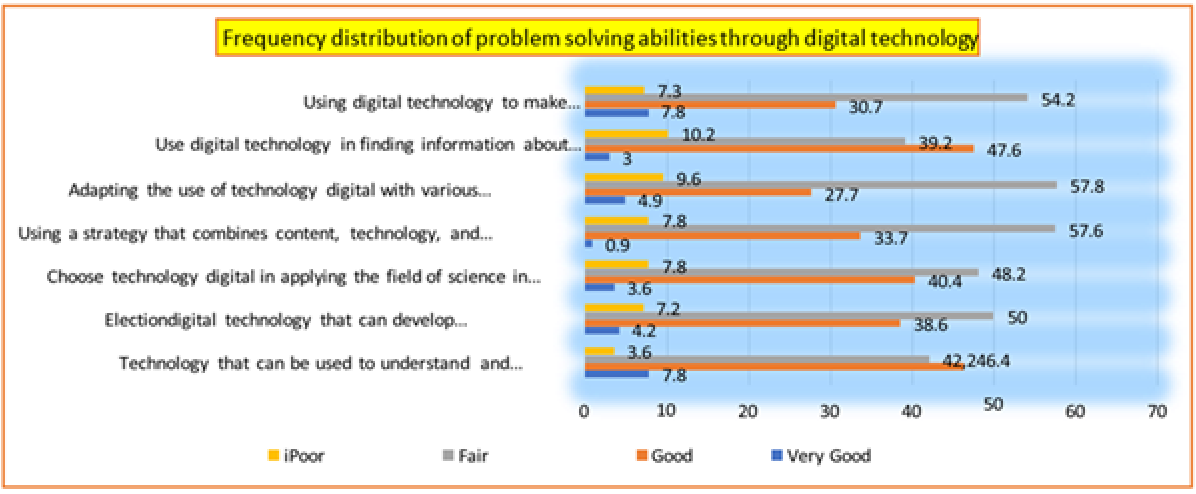
3.1.1. Components of student interests and Attitudes on the Use of digital technology



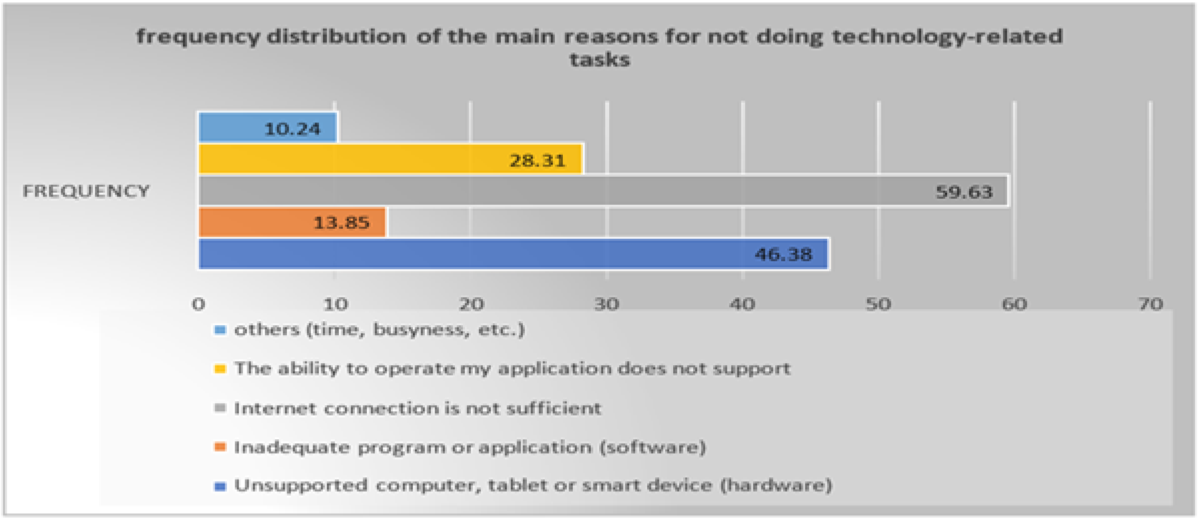
3.1.2. Component of software/application mastery competence



3.1.3. Mathematical problem-solving skills through digital technology



3.1.4. Components of the main cause of students not completing assignments related to digital technology



3.2. Discussion

3.2.1. Profile of Access to Digital Technology and the Internet

In general, there are three basic factors(Base, 2020) that have contributed to the quality of learning by using digital technology, namely:

a. Devices and Internet Connections. When the network and internet connection is not stable enough, the digital learning system will never function properly. According to 2019 Kominfo data, there are still around 24,000 regions that do not yet have internet access. When the education system starts using e-learning, either exclusively or in conjunction with other methods, the above situation will become a serious problem. Therefore, every e-learning platform must have stable and fast data and internet connection.

b. Quality of lecturers. Not only the Internet, but an effective e-learning system also requires lecturers with high-calibre technological expertise. Simply put, students who attend school need to master digital technology and infrastructure to learn. In addition, lecturers must be proactive and creative in developing teaching materials so that they do not lose their cool when teaching in online classes or through e-learning;

c. Digital Learning Platform. The quality of online learning will increase with the use of e-learning platforms. For this reason, developing an innovative digital education platform is one of the factors that have succeeded in preventing the failure of certain educational processes.

The current era of digital technology disruption is highly dependent on the availability of internet access, the degree of digital literacy, and the ability to use technological devices. This condition can be seen from the profile of access to digital technology respondents. The profile of access to digital technology owned by respondents is largely determined by 2 components, namely the component of laptop/mobile ownership and the component of ease of internet access. The available data shows that 92.2% have laptops and mobile phones, and from that number, it is illustrated that as many as 70.5% have smartphones with the type of smart devices. On the internet access side, it shows that 77.1% have internet access at home and 91.6% have internet access on campus. The locations of the campus areas that access the internet the most are academic rooms (department/faculty) as much as 51.8% and open spaces for the public (parking, parks, etc.) as much as 49.4%. The rest often access the internet in lecture halls, libraries, and campus corridors.

The description of the data above shows that some students still have not carried out the optimal access process due to the constraints experienced by the respondents. This condition will affect students' ability to improve their digital technology literacy, especially in facing future challenges. This is crucial because the Network of Digital Literacy Activists (Japelidi) categorizes digital literacy into 10 competencies: accessing, selecting, understanding, analyzing, proving, evaluating, distributing, producing, participating, and collaborating (Satria, 2020). The emphasis in the early stages is on access to technology as one of the most crucial things because, without access, it is certainly impossible for individuals to enter/switch to other stages of digital literacy skills. Of course, this is closely related to the learning infrastructure that students have.

3.2.2. Interests and Attitudes Towards the Use of Digital Technology

The development of digital information and communication technology is closely related to digitalization which is packaged in the form of information technology and interactive educational software. It is an avenue to enrich education by integrating technology into traditional classrooms. In addition, technology is a good resource for lecturers and students to support the teaching and learning process. On this side, the factors of interest and attitude toward the use of digital technology provide a link to the success of this learning process.

Research findings show that students' interest in digital technology between personal needs, academic needs, and their learning success shows a range of differences. In the extraordinary category, the dominance of their interest is in learning purposes and completing college assignments as much as 71.1%, while others are for personal purposes and learning success. Then on the side of students' beliefs about the role of digital technology in their future in solving their problems, only 48.2% in the almost every time category and 40.4% in some times.

Building a digital literacy culture needs to be supported by a positive interest and attitude toward digital technology itself. The success of building digital literacy is one indicator of achievement in the fields of education and culture. The real success of digital literacy, of which is realized by the growing public awareness to use the internet intelligently and positively. Attitudes toward digital technology play an important role in building the digital divide among students as evidenced by a significant direct correlation with access to IT, digital competence, and frequency of Internet use (Sayaf et al., 2022).

3.2.3. Digital Technology Competence

The development of this technology brings changes to the quality and efficiency of the data capacity that is created and transmitted, such as; images becoming clearer due to better quality, more efficient capacity, and faster delivery processes. The position of digital technology is that computer-based/digital information technology is a tool that tends to operate on a fully automated and sophisticated operating system with a computerized system/format that can be read by a computer. Digital technology is just a very fast computing system that processes all forms of information as numerical values and greatly helps the quality and work of a person, especially in the problem-solving process.

The logical consequence of this context is the ability to master this digital technology for users. Application-based digital technology, especially in learning. The available data shows that students have little mastery and are incompetent in several applications that will support their ability to solve problems, including spreadsheet applications (e.g., Microsoft Excel, OpenOffice Calc); Graphics processors (example: Paint, IrfanView, Adobe Photoshop, Paint Shop Pro); Digital Image Recording (example: with Digital Cameras and Scanners); Multimedia compilation (example: Adobe Flash); Mind/Concept Mapping (example: Inspiration, MindMapple, MindJet); Digital Video Processing (example: Adobe Premier, MovieMaker, iMovie); Online Classroom Management (Moodle, Blackboard, Edmodo, Schoology, Kelase); and Online Publishing (WordPress, Blogspot, podcasts, video publications on YouTube). While other applications that are often used by students, generally provide an overview of mastery and mastery, such as Word Processing (e.g., Microsoft Word, OpenOffice Writer); Word Processor (example: Microsoft Word, OpenOffice Writer); Email (Outlook, Gmail, Lotus, Yahoo); etc.

The fact is that students need to acquire the necessary technical competencies to meet their needs during their studies. However, as emphasized by Hughes & Scharber (2014), it is not enough to just introduce technology into ITE. Lecturers also need to acquire knowledge of technological pedagogical content (TPCK), which enables them to use technology effectively. More precisely, students and lecturers must master technological knowledge, which includes basic and advanced technology, content knowledge which refers to the subject matter to be studied and taught, and pedagogical knowledge which means processes and practices, or methods, of teaching and learning.

This information becomes a reflection material that in the learning process using digital technology, students' ability to master applications is still not optimal, especially applications that are rarely used in doing college assignments. Digital learning requires competence or ability digitally because learning is oriented toward problem-solving-based learning, including utilizing technological instruments as learning aids (as a tool) that support learning in accelerating and expanding knowledge and information if there is the ability to use digital technology or applications used in the problem-solving process. This competency does not merely demonstrate proficiency in digital technology but requires the appearance or performance of the process.

Furthermore, findings on the context of (a) mastery of digital technology technical problems without the help of others (76.5%); (b) having the necessary skills in using digital technology in achieving the objectives of the courses being followed (88.6%), (c) adapting course materials based on what is currently known and unknown through digital technology (89.6%), and (d) active learning with the support of digital technology (88.55%); The research findings show that this competency is good enough, it just doesn't provide optimal numbers. Web/internet-based digital learning complements the delivery of digital learning. Computer-based learning is very effective in making education better and strongly supports the minimum competencies of students in the 21st century (Ananiadou & Claro, 2009; Macann & Carvalho, 2021).

3.2.4. Problem-Solving Ability through Digital Technology

It is believed that problem-solving is mechanistic, systematic, and frequently linked to abstract notions activity. Capabilities The process of issue-solving involves defining a problem, figuring out its root cause, locating, ranking, and choosing potential solutions, as well as putting those ideas into action (Tong et al., 2022). In this situation, the issue at hand is one that can only have one solution, which is attained through a single procedure (convergent reasoning). Problem-solving is viewed as a mental activity requiring sophisticated cognitive abilities in accordance with the advancement of cognitive learning theory. Higher-order cognitive abilities including imagery, association, abstraction, manipulation, reasoning, analysis, synthesis, and generalization are necessary for problem-solving. Problem-solving has various roles, namely (1) problem solving as a context for doing mathematics, which is to function problems to motivate students to learn mathematics (Van Bommel & Palmér, 2015).

According to the concept as it is presented, problem-solving in this context means learning how to do it well and with enthusiasm, as well as how to become independent thinkers who can solve both closed and open situations. Existence of digital technology is one of the current media that is very helpful. The study's statistics show that the level of mastery is very good and good on a number of test items, pointing to a respectable but not perfect state. Some of the items include (a) Technology that can be used to understand and apply course assignments (88.6%); (b) Selection of digital technology that can develop problem-solving skills (88.6%); (c) Choosing digital technology in applying the field of science in learning in elementary schools (88.6%); (d) Using a strategy that combines content, technology, and approach in solving problems in course assignments and assignments outside the course (90.3%); (e) Adapting the use of digital technology with various functions for the process of developing problem-solving skills (85.5%); (f) Using digital technology in finding information about coursework (86.8%); and (g) Using digital technology to create products/work on product-based tasks such as posters, presentations, etc. (74.9%). (e) Adapting the use of digital technology with various functions for the process of developing problem-solving skills (85.5%); (f) Using digital technology in finding information about coursework (86.8%); and (g) Using digital technology to create products/work on product-based tasks such as posters, presentations, etc. (74.9%). (e) Adapting the use of digital technology with various functions for the process of developing problem-solving skills (85.5%); (f) Using digital technology in finding information about coursework (86.8%); and (g) Using digital technology to create products/work on product-based tasks such as posters, presentations, etc. (74.9%).

The data shows that students have made digital needs into a special need in learning. The internet with all the ease of access to information can be the most complete library in the world, or it can even be the most pleasant classroom that is so flexible. The continuous development of technology will have an impact on skill needs in the future. In this regard, Bondarenko et al. (2021) stated that the need for digital technology in universities can overcome the challenges of facing 10 skills that are highly sought after in 2025, namely (1) analytical thinking and innovation; (2) active learning and learning strategies; (3) complex problem-solving; (4) critical thinking analysis, (5) creativity, originality, and initiative, (6) leadership and social influence, (7) technology use, mentoring, and control, (8) Technology design and programming; (9) Resilience, stress tolerance, and flexibility; (1) Reasoning, problem-solving, and ideation.

3.2.5. Factors Inability to Complete Tasks/Problems

The main reasons for not being able to complete lecture assignments/problems that require digital technology include (1) computers, tablets, or smart devices (hardware) that do not support (46.39%); (2) Inadequate program or application (software) (13.86%); (c) Inadequate internet connection (59.64%); (d) The ability to operate the application does not support (28.31%). This data provides information that there are still many factors that can provide gaps so that digital technology cannot be optimally used by students in solving problems, especially college assignments. This condition shows that digital technology has dark side effects and is associated with negative cognitive and affective outcomes (Marsh et al., 2022). The use of digital technology for problem-solving is determined by attitudes, interests, and available resources, especially in a university environment.

4. CONCLUSION

Exploration of the integration of digital technology in solving problems in learning for PGSD students is very dependent on factors (a) student access to digital technology and the internet;(b) interest and attitude towards the use of digital technology; (c) digital technology competence; (d) problem-solving ability through digital technology and (e) the inability to complete tasks/problems. The findings of this study indicate that students generally give a very positive response to points (a) and (b), but at points (c), (d), and (e) they have not optimally provided ideal conditions. The need for the provision of digital technology-based learning content, especially in the problem-solving process, should consider quality, meaningful, and user-cultural support. Thus, future studies are encouraged to scrutinize such issues.

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