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Unraveling the connection: Digital competence and steam readiness in biology pre-service teachers

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ABSTRACT

Digital competence is one of the things that pre-service teachers need to have in order to survive in global competition. The goal of this reasearch is to know the correlation between digital competence of biology pre-service teachers and their readiness to apply STEAM-oriented learning. This research is a bivariate correlational quantitative research. The sampling technique used in this study is the quota sampling technique with number of sample are 90 students. The instrument used in this study was a questionnaire to measure students' digital competency skills and their readiness for STEAM. The data analysis technique in this study is inferential statistical analysis in the form of a bivariate correlation test (Spearman Rank correlation). The Correlation Coefficient value shows a coefficient of 0.622, meaning there is a strong relationship between digital competence and readiness for STEAM. The digital competence of pre-service teachers is considered necessary in STEAM-oriented learning because technology and digital tools play an essential role in improving the quality of learning and enabling more interactive, innovative, and fun learning experiences.

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INTRODUCTION

The industrial revolution 4.0 has significantly impacted the world of education. Currently, education is increasingly shifting towards digital-based education. Laser (2019) explained that several things, including increased connectivity and the development of digital systems, marked the era of the industrial revolution 4.0. Every college, including Educational Institutions, cannot avoid these changes. Educational Institutions need to adapt to current advances in digital technology. As an institution that educates prospective teachers, they need to equip each student with various skills relevant to the world of work in the future. Communication skills, discussion, problem-solving, critical thinking, and creative thinking to digital competence must mature before students become teachers (Adhani et al., 2022).

Digital competence is one of the things that pre-service teachers need to have in order to survive in global competition. Makiyah et al. (2020) stated that digital competence is recommended for lifelong learning. Further explained by (Makiyah et al., 2020; Basilotta et al., 2022) that digital competence is the ability of an educator to use information and communication technology which has implications for learning. Prospective teachers must face technological innovation and modern telecommunications in the digital era (Ismail et al., 2020) as a form of readiness to enter the world of work. Today's teachers must be trained to use digital technology as a natural part of their daily lives (Cantabrana et al., 2019). Novitasari & Fauziddin (2022) stated that learning facilitated with digital devices will make it easier for teachers and students to access the information needed, including in learning biology.

Biology as a field of science is closely related to STEAM (Science, Technology, Engineering, Arts, and Mathematics). STEAM facilitates students to be better able to deal with real-world problems. According to Suganda et al. (2021), students in the 21st century need skill-based education that they can utilize to solve various problems encountered in everyday life. STEAM itself is a refinement of the pre-existing STEM approach. STEAM allows teachers and students to use a fun way of learning a discipline or interdisciplinary knowledge. According to Alghamdi (2022), STEAM is an educational philosophy integrating five main disciplines (Science, Technology, Engineering, Arts, and Mathematics) to support children's natural curiosity and encourage their internal excitement for exploration and discovery. The existence of Arts "A" in STEAM provides opportunities for students to use their creativity and imagination in studying various disciplines.

Previous researchers have widely reported the advantages of STEAM-oriented learning. STEAM is becoming increasingly urgent to implement in learning, considering digitalization has become an inseparable part of 21st-century learning. Several studies have revealed that teachers still need more confidence in their digital competence. During the Covid-19 pandemic, many studies reported that teachers experienced problems when they had to teach online and use various applications or digital platforms. Teachers must still learn to operate hardware and software in online learning (Nopiyanto, 2020; Mawaddah & Puspasari, 2021). In the current era of digitalization, teachers and pre-service teachers must have skills in operating or accessing digital devices. Thus, the researcher is interested in further studying the correlation between the digital competence of biology pre-service teachers and their readiness to apply STEAM-oriented learning.

METHODS

Research Design

This research is a bivariate correlational quantitative research. This correlational study was used to find the relationship between two variables, namely the independent variable (X) and the dependent variable (Y). In this study, digital competence is the X variable, while STEAM readiness is the Y variable. Apart from the correlation, this study will also look at the correlation's direction and the correlation strength between these variables.

Population and Samples

The population in this study were all students majoring in Biology Education at the Faculty of Education and Teacher Training, Borneo Tarakan University. The sampling technique used in this study is the quota sampling technique. The quota sampling technique is carried out by determining the number of targets (quotas) with specific criteria from a population (Fauzi, 2019). The criteria used in this study are that the sample used is students who still need to program their thesis (Class of 2019-

2021). The researcher used his expert judgment to meet the number of samples for each stratum. The number of students used as the sample is 90, with each batch of 30 people taken as samples.

Instrument

The instrument used in this study was a questionnaire to measure students' digital competency skills and their readiness for STEAM. The digital competency questionnaire used consists of 5 aspects with a total of 31 statements. The aspects of digital competency measured are Information and Data Literacy, Communication and Collaboration, Digital Content Creation, Safety, and Problem-Solving. While the questionnaire used to measure STEAM Readiness consists of 3 aspects with a total of 15 statements. The measured aspects of STEAM Readiness are knowledge related to STEAM, opportunities for STEAM implementation, and STEAM readiness. The two questionnaire types used a Likert scale of 1-4.

Procedure

The research procedure consists of 4 stages, namely (1) preparation; (2) data collection; (3) data analysis, and (4) conclusion. At the preparatory stage, the researcher compiled a research instrument that would be used in data collection in the form of a questionnaire. Before use, the questionnaire is validated internally by the language and content/construct validators. The data collection stage was done by distributing validated questionnaires to research samples via Google Forms. The questionnaire data that has been obtained is then analyzed statistically and then followed by concluding the final stage of the research.

Data Analysis Techniques

The data analysis technique in this study is inferential statistical analysis in the form of a bivariate correlation test. The type of correlational test chosen is the Spearman Rank correlation based on the selection because the type of data obtained in this study is ordinal data (questionnaire data), so the appropriate correlation test is Spearman Ranks (Al-Hameed, 2022). This correlation test is a nonparametric statistical test, so it does not pass the normality or homogeneity tests. Bivariate correlation testing uses the SPSS version 22 program where if the Sig. 2-tailed <0.05, it is stated that there is a relationship between the two variables. Meanwhile, the correlation coefficient's value can show the relationship's strength between variables and the direction of the relationship. The following is an interpretation table of the correlation coefficient to see the strength and direction (+ or -) of the relationship between variables (X and Y).

Table 1

Interpretation of Coefficient Correlation Value of X and Y

Coefficient Correlation	Interpretation
0,00 – 0,199	Very Poor
0,20 – 0,399	Poor
0,40 – 0,599	Enough
0,60 – 0,799	Strong
0,80 – 1,00	Very Strong

(Evans, 1996)

RESULTS AND DISCUSSION

This section presents statistical test results using the Spearman Rank correlation test on digital competence (X) and STEAM readiness (Y) variables for biology pre-service teachers. Table 2 shows a correlation between digital competence and the readiness to apply STEAM by biology pre-service teachers. The acquisition of Sig evidences these results. (2-tailed) which is smaller than 0.05 (0.000 < 0.05). The Correlation Coefficient value shows a coefficient of 0.622, meaning there is a strong relationship between digital competence and readiness for STEAM. A positive value on the Correlation Coefficient means that the two variables have a unidirectional relationship. The better the digital competence, the more prepared the biology pre-service teachers are to implement STEAM-oriented learning.

Table 2
Rank Spearman Correlation of Digital Competence to STEAM Readiness

			Digital Competence	STEAM
Spearman's rho	Digital Competence	Correlation Coefficient	1.000	.722**
		Sig. (2-tailed)	.	.000
		N	90	90
	STEAM	Correlation Coefficient	.722**	1.000
		Sig. (2-tailed)	.000	.
		N	90	90

Digital competence is one of the 21st-century skills students need (Bellanca & Brandt, 2010; Rokenes, 2014). The Covid-19 pandemic has made educators and students more aware of the importance of digital competence in learning (Sillat et al., 2021). According to Fraile et al. (2018), digital competence is the skills and knowledge needed to use digital technology in everyday life and work creatively, critically, and safely. Digital competencies of teachers refer to the skills, knowledge, and attitudes necessary for effectively using digital technologies in educational contexts. With the increasing use of technology in classrooms and remote learning environments, teachers need digital competencies to ensure they can provide their students with a high-quality education. According to Vourikari et al. (2022), digital competence includes five aspects, namely information and data literacy, communication and collaboration, digital content creation, safety, and problem-solving.

Information and data literacy is related to seeking, finding, evaluating, and using information and data effectively. According to the European Commission (2018), information and data literacy is an aspect of digital competence that demonstrates the ability to search, evaluate and use information from various sources, including data, to solve problems and make the right decisions. The pre-service teacher needs to be able to find, evaluate, and use information effectively and efficiently. Information literacy enables teacher candidates to identify appropriate online resources, organize information in easy-to-understand formats, and validate information before using it in lessons. Individuals with information and data literacy competencies can better process and evaluate information from various sources (Marguna, 2020; Meylina et al., 2021). It can help biology pre-service teachers to make better and more precise decisions in STEAM-oriented learning.

Communication and collaboration are related to the ability to communicate and work together using digital technology. Communication and collaboration are the ability to communicate effectively with others using digital technology and work in teams and collaborate through digital technology. Prospective teachers need to have the ability to collaborate online with others in the context of STEAM learning. These collaboration skills allow teachers to work closely with students, colleagues, and experts in the STEAM field to achieve learning goals. Communication and collaboration are crucial in the implementation of STEAM because STEAM is an approach that applies various interdisciplinary knowledge that teachers use in achieving a learning goal. In addition, research from Rokenes (2014) reports that teacher involvement in the professional community can help them to improve and maintain their digital competence. By sharing experiences and knowledge with colleagues and experts in the STEAM field, teachers and prospective teachers can gain new insights and perspectives to enrich their students' learning experiences. Further explained by Voogt and Roblin (2012) further explained that individuals who can communicate and collaborate digitally can work effectively in teams and obtain better results.

Digital content creation relates to creating and producing works using digital technology. Student teacher candidates should have the ability to use digital technology and software needed in STEAM learning. These skills enable them to facilitate and support innovative and compelling learning experiences within STEAM learning contexts. In addition, this aspect allows them to use digital technology in making creative products (Alghamdi et al., 2022). It is essential to facilitate the creative process in STEAM learning and improve the ability of student teachers to develop and present innovative ideas. It aligns with the opinion (Ferrari et al., 2012; Alexander et al., 2017) that digital content creation includes creating digital images, videos, audio recordings, animations, simulations, games, and other multimedia materials used to enhance the learning experience. Teachers who create,

develop, and use varied and innovative digital content can help increase student motivation, engagement, and understanding of complex STEAM concepts. Therefore, teachers must develop this ability as part of their digital competency.

The next aspect is the safety aspect. This aspect relates to the ability to use digital technology safely and responsibly. These competencies are essential in protecting oneself from digital threats. Based on research conducted by Ghafouri et al. (2020), individuals with digital security competence can better protect themselves and others from threats such as malware and phishing. Research by Drossel et al. (2019) also highlighted the importance of paying attention to digital safety aspects in using technology in learning. This research shows that students and teachers must be trained about digital risks and how to take precautions and actions in dealing with dangerous situations that can arise from using various applications, websites, or learning platforms. It is supported by Kim et al. (2018), which show that training on digital safety is crucial in helping teachers acquire and develop digital competence. Teachers should be trained on digital risks and how to take precautions and actions in dealing with dangerous situations.

Problem-solving is related to the ability to use digital technology to solve problems. Every educator should be able to solve complex problems using digital technology in the current digitalization era (Castek et al., 2018). These skills enable teacher candidates to design and implement STEAM projects that require creative and innovative solutions. The ability to solve problems using digital tools and technologies is becoming increasingly important in the modern workplace. Digital technologies can help individuals and organizations solve problems more efficiently and effectively, improving productivity and decision-making (Wang et al., 2022). Problem-solving in digital competencies is critical for success in the modern workplace. Practical problem-solving in the digital age requires combining technical, analytical, and critical thinking skills (Harnani, 2021; Hollenstein et al., 2022). As technology advances, individuals and organizations must prioritize developing and enhancing their problem-solving skills to stay ahead and thrive in the digital age.

Incorporating innovation and technology into the classroom requires support from various aspects, such as infrastructure, devices, and human resources (European Commission, 2018). Prospective teachers must be familiar with using digital devices as an adaptation effort for STEAM implementation. Porras et al. (2022) reported that using digital technology, such as simulations and computer games, positively impacts STEAM learning and improves students' problem-solving skills, critical thinking, and creativity. Further explained by Nong et al. (2022) that the participation of educators in STEAM, which integrates science, technology, engineering, art, and mathematics is more beneficial for students to acquire 21st-century skills such as communication, collaboration, learning innovation, and critical thinking. STEAM-based learning (Science, Technology, Engineering, Arts, and Mathematics) requires skills and abilities in technology, thus requiring teachers with adequate digital competence. A study by Alghamdi et al. (2020) found that digital competencies were critical in promoting student engagement in STEAM learning. Teachers with solid digital competencies created engaging learning experiences that motivated students to participate in learning activities and develop their skills (Akbar & Biyanto, 2022). Therefore, pre-service teachers must develop their digital competence to remain effective in their profession and support student learning in STEAM. The digital competence of pre-service teachers is considered necessary in STEAM-oriented learning because technology and digital tools play an essential role in improving the quality of learning and enabling more interactive, innovative, and fun learning experiences.

CONCLUSION

In conclusion, there is a strong relationship between teachers' digital competency and STEAM-oriented learning. Teachers with adequate digital competence can facilitate innovative and interactive learning experiences, help students develop the technological skills needed in the STEAM field, and promote effective and innovative STEAM-based learning.

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