

The Relationship between Technological Pedagogical and Content Knowledge (TPACK) and Technology Integration Self Efficacy (TISE) of Biology Teachers

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Abstract: High school biology teachers' good TPACK and TISE abilities will affect students' Biology learning outcomes. This study aims to determine the TPACK and TISE abilities of high school biology teachers in Banda Aceh City. this research is a survey research with a quantitative approach with a correlational design. The population in this study were all high school biology teachers in Banda Aceh City and using the total sampling method, the total sample was 49 high school biology teachers. Data collection was carried out by means of questionnaires, interviews and observations. The TPACK questionnaire contains 36 question items and the TISE questionnaire contains 28 question items. For interviews there are 25 question items. TPACK observations contain 28 observation items and TISE contains 14 observation items. For correlation values between TPACK and TISE, the Pearson Product Moment correlation formula is used. Based on the results of the study, it is known that there is a significant and positive correlation between the TPACK and TISE abilities of biology teachers at public high schools in Banda Aceh City.

Keywords: Biology teacher; TISE; TPACK

Introduction

The 21st century is marked by the rapid development of Information and Communication Technology (ICT). Technological developments have an impact on all sectors of life, one of which is the education sector (Oke & Fernandes, 2020). Digital literacy is a key to the industrial revolution 4.0. Digitalization of education must also continue to be adjusted both in schools and other educational institutions (Reddy et al., 2023). The success of a country in facing the industrial revolution 4.0 is also determined by the quality of educators such as teachers (Sima et al., 2020) Law Number 14 of 2005 concerning Teachers and Lecturers which states that teachers are obliged to improve and develop academic qualifications and competencies on an ongoing basis. This is in line with the development of science, technology and art. Therefore, teachers need to master ICT so that learning is in line with current

developments. ICT mastery is needed by teachers to be able to integrate technology in learning according to the demands of 21st century education (Astuti et al., 2019).

Teachers are professionals who have an important role in shaping society to be more competitive (Farida & Setiawan, 2022). The teacher's task is not only to teach lessons but also to make the experience more interesting so that it can be learned make it easy for students to understand lessons (Keiler, 2018). Teachers are required to master skills, the ability to adapt to new technologies and global challenges. In this situation, every educational institution must prepare a new orientation and literacy in the field of education (Valladares, 2021). Old literacy that relies on reading, writing and mathematics must be strengthened by preparing for new literacy, namely data literacy, technology and human resources. Data literacy is the ability to read, analyze and use information from data in the digital world.

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Regarding teacher competence, data obtained from the Regional Education Balance (NPD) shows the results of the Teacher Competency Test (UKG) with the UKG scores for junior and senior high school teachers in Aceh Province being in the third lowest rank with a scale of 45.49 and 51.05 on the national scale. This is of course in line with the literature study that has been conducted in Aceh Province, namely in Aceh Besar District and Banda Aceh City which noted that the TPACK competence of science teachers was still lacking. Biology learning requires tools (media) to explain abstract biology lessons to students. To overcome abstract biology learning, you can use ICT in biology learning. To be able to integrate ICT in the learning process, teachers must master knowledge of technology that is integrated with pedagogical and content knowledge (Malik et al., 2019). The integration of pedagogic, content and technological knowledge in order to realize ICT-integrated learning is called Pedagogical Knowledge Technology and Content (TPACK) (Nuruzzakiah et al., 2022).

Technological Pedagogical and Knowledge (TPACK) is one of the learning designs. TPACK is a framework that contains the knowledge needed to integrate technology into learning. This framework was developed by Mishra et al. (2006) based adaptation of Pedagogical Content Knowledge (PCK). Technological Pedagogical and Content Knowledge (TPACK) is a meeting point where technology (computer, video, visual), pedagogy (teaching methods, learning models), and content (such as science, geography, and mathematics) are used together (Chen et al., 2022). The results of the 2022 public education report card for Aceh province at the State Senior High School level with a total of 403 education units and a total of 9.67 teacher respondents show that in the quality of students' learning process in the teacher reflection index section, it was found that efforts to improve the quality of learning were sporadic just to complete assignments (Dwivedi et al., 2023).

Technology Integration Self Efficacy (TISE) or self-efficacy in integrating technology in teaching is also considered as a factor influencing a teacher's decision to use technology in the classroom (Hershkovitz et al., 2023). The existence of self-efficacy towards integrating technology in teachers influences the way teachers adapt to existing technology in education (Afari et al., 2023) also said that increasing teachers' self-efficacy in integrating technology has a positive effect on their teaching process and their students' learning. Therefore, teachers must also have self-efficacy in integrating technology to develop their ability to use ICT in the teaching and learning process.

Previous researchers have conducted a lot of research on TPACK among teachers and 21st century learning in the classroom. The need to integrate 21st century technology and skills in teaching has made it difficult for teachers to educate students to achieve national goals and ideals (Kim et al., 2019). Previous researchers have conducted studies and discussed teacher TPACK levels challenges to implementing TPACK in teaching (Papanikolaou et al., 2017), development and validation of TPACK measurement instruments (Suryani et al., 2021), the integration of technology in education (Hartman et al., 2019), and the integration of 21st century skills in teaching and learning (Almazroa & Alotaibi, 2023). In previous studies, the competency criteria for the TPACK component of Biology teachers in Aceh Province were CK 80.98% (very good), Kindergarten 76.84% (good), PK 83.35% (very good), PCK 82.43% (very good), TCK 80.27% (good), TPK 81.98% (very good) and TPACK 78.42% (good). The TK, TCK and TPACK scores obtained were in the good category with the results obtained based on the results of filling out a questionnaire via Googleform (Nuruzzakiah et al., 2022).

Method

Table 1. Number of Biology Teachers in Banda City Public High Schools

School Name	Number of Biology Teachers
SMA Negeri 1 Banda Aceh	4 People
SMA Negeri 2 Banda Aceh	4 People
SMA Negeri 3 Banda Aceh	3 people
SMA Negeri 4 Banda Aceh	3 people
SMA Negeri 5 Banda Aceh	3 people
SMA Negeri 6 Banda Aceh	2 persons
SMA Negeri 7 Banda Aceh	5 People
SMA Negeri 8 Banda Aceh	3 people
SMA Negeri 9 Banda Aceh	3 people
SMA Negeri 10 Banda Aceh	4 People
SMA Negeri 11 Banda Aceh	4 People
SMA Negeri 12 Banda Aceh	5 People
SMA Negeri 13 Banda Aceh	2 persons
SMA Negeri 14 Banda Aceh	2 persons
SMA Negeri 15 Banda Aceh	2 persons
SMA Negeri 16 Banda Aceh	1 person
SMA Keberbakatan	1 person
Olahraga Negeri Aceh	

This research is included in survey research with a quantitative approach with a correlational design. Correlational design research is research that aims to find whether there is a relationship and to find out how close the relationship is and whether or not the relationship is meaningful. The research was carried out in the odd semester of 2022/2023. The location for this research was carried out in all public high schools in

Banda Aceh City. The population taken in this research were all biology teachers from 17 public high schools in Banda Aceh City, totaling 49 people. Data on the number of teachers in 17 public high schools in Banda Aceh City can be seen in Table 1. An image of the research flow chart can be seen in Figure 1.

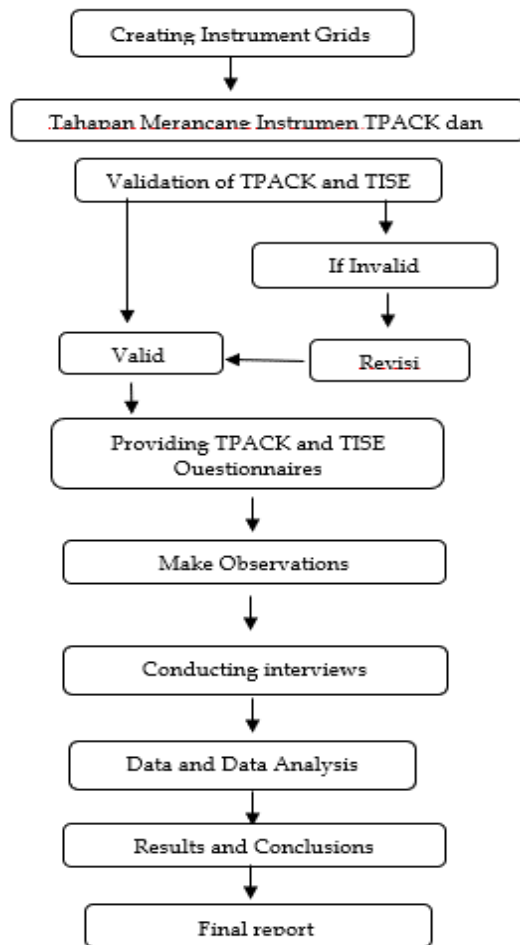


Figure 1. Research flow chart

This research uses 2 variables, namely: Variable X: Technological Pedagogical Content Knowledge (TPACK); Variable Y: Technology Integration Self Efficacy (TISE). A questionnaire is a data collection technique using a set of statement lists totaling 34 statement items related to TPACK and 32 statement items related to TISE which have been compiled and then distributed to respondents to obtain the necessary data. The questionnaire in this research was created based on a Likert scale. The correlation test used is the Pearson's Product Moment Correlation test. Pearson's Product Moment Correlation is used to determine the degree of relationship between the independent variable and the dependent variable.

Result and Discussion

The results of the correlation test between the TPACK and TISE abilities of public high school biology teachers in the city of Banda Aceh are presented in Table 2.

Table 2. TPACK and TISE Correlation Values

Change	TPACK (X)	TISE (Y)	Correlation V	Determinant Coefficient (R ²)
Mark	139.30	115.60	0.61	0.36

Based on the table above, it can be seen that the correlation value between TPACK and TISE is $r = 0.61$. This shows that TPACK and TISE have a positive correlation with a strong interpretation. Based on this correlation, it is known that the higher a person's TISE score, the impact on the TPACK value. To determine the magnitude of this relationship, it is determined from analysis of the coefficient of determination (R²) of 0.360. This shows the ability of the TISE variable to influence TPACK by 36%, while 64% is influenced by other factors. Another factor of 64% includes the other TPACK components, namely CK, PK, and PCK which makes the results that affect the value of the TISE and TPACK relationship only by 36%.

Next, a correlation hypothesis test was carried out between TPACK and TISE abilities shown in Table 3.

Table 3. TPACK and TISE Correlation Test

Group	TPACK (X)	TISE (Y)	t test	Information
Mark	139.30	115.60	12.42 > 1.67	Sig
			$t_{count} > t_{table}$	

Based on Table 3, it shows that the correlation coefficient (r) is significant between TPACK and TISE capabilities. This can be seen from the statistical test between the correlation of TPACK abilities (variable X) and TISE (variable Y), namely ($t_{count} 12.42 > t_{table} 1.677$), this shows that between TPACK and TISE abilities high school Biology teachers in Banda Aceh City there is a strong correlation significant. An illustration of the regression between the TPACK and TISE abilities of high school Biology teachers in Banda Aceh City is shown in Figure 2.

Figure 2 explains the direction of the regression between the TPACK and TISE variables. From the average TPACK score of 139 and TISE of 115, a scatter diagram is formed which forms a regression line with the equation $y = 48.586 + 0.4813x$. From the equation of the line formed, it can be seen that there is a correlation between the TPACK and TISE abilities of State High School Biology teachers in Banda Aceh City. The regression prediction of TPACK and TISE capabilities shows that as TPACK increases, TISE capabilities will

also increase and vice versa. This can be seen from the linear line that is formed leading to positive regression. Figure 1 shows that there is a contribution from TISE to TPACK. If the TPACK score (X), If the TPACK (X) score is equal to 0 then TISE (Y) has a score of 48, which means that with very low TPACK ability the respondent has TISE ability is also low, namely 48. However, if the respondent has a very high TPACK with a maximum score of 180, the TISE ability value will increase to 135, which indicates a good category. Thus, it can be concluded that the higher the TPACK ability, the higher the TISE ability of State High School Biology teachers in Banda Aceh City.

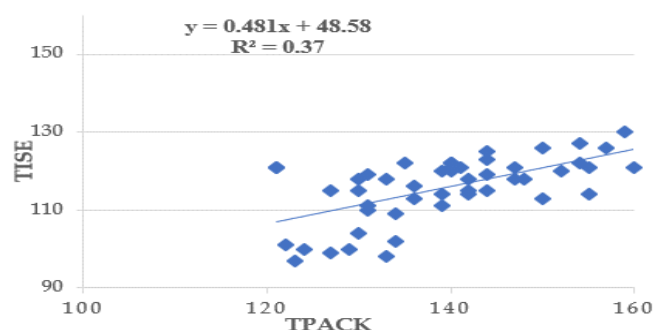


Figure 2. Regression between TPACK and TISE

According to Valtonen et al. (2023) teachers' TPACK is not only limited to understanding certain approaches to teaching, instructional processes, or even technology integration. A flexible and inclusive PD program based on TPACK is important to accommodate various philosophies, teaching styles, and teaching approaches so as to encourage teachers to choose based on suitability with reference to student learning needs and preferences, as well as familiarity with the combination. TPACK in every learning planning process and its implementation in the classroom. Based on the research results of (Iswadi et al., 2023), it can be concluded that there is a significant difference in the TPACK ability of science teachers based on the differences between generations X and Y. Furthermore, the TPACK ability of generation Y science teachers shows a higher percentage than generation X, especially in the PCK component (Ibrohim et al., 2022). The results of this research also provide important information to students and lecturers at educational institutions, such as FKIP, so that they update and improve their content knowledge, pedagogical knowledge and technological knowledge. Because these three components will continue to develop according to the times, teachers must also always be active in their professional organizations, for example MGMP, to share and improve TPACK abilities.

Things that need to be discussed further are in accordance with the research results of (Bahtiar et al., 2023) explaining that the results of density mapping analysis of themes that are rarely researched are ICT investigations, curriculum, effectiveness, teacher knowledge, foreign languages, teacher education, TPACK instruments. According to (Subagja et al., 2023), the implementation of TPACK-based interactive multimedia improves students' science process skills. Integrating inquiry-based learning models into media-based learning Technology is a step towards creating ideal learning for the 21st century (Wen et al., 2023).

Based on research results Ismail et al. (2023) said that learning technology has not been utilized optimally by teachers as references, learning resources and learning media. The application of TPACK is also designed before carrying out learning activities, the teacher tries to integrate technology learning by paying attention to the use of strategies that combine material, technology and learning strategies. To implement effective TPACK-based learning requires support from school facilities such as internet networks, computers, LCDs and the teacher's own abilities. This is an obstacle in the implementation of TPACK-based learning. In addition, it is necessary to hold training or workshops to improve the ability of teachers to use technology in learning (Coman et al., 2020).

Randika et al. (2020) said that the way teachers implement learning is one of the keys to successful teaching and learning in the classroom. Teachers play an important role in conveying material to students so that they can receive as much knowledge as possible both from the teacher and from the material. In addition, teachers must be aware of the impact of TPACK, TISE, and ITOE on student learning. Darling-Hammond et al. (2020) research results based on the results of statistical analysis tests and interviews, it can be concluded that subject mastery has a contribution to enriching prospective teachers' knowledge about learning in schools, as well as helping prospective teachers to have the ability to develop learning media. The courses obtained also provide knowledge related to various learning models and media that can be applied in learning.

Conclusion

There is a significant and positive correlation between the TPACK and TISE abilities of public high school biology teachers in Banda Aceh City.

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Author Contributions

YS writes meta-analysis articles based on JPPIPA templates and revises it based on comments. CN helps collect similar articles and analyzes data. KH, MH and SF provide ideas, guide and direct, and review this article.

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Conflicts of Interest

The authors declare that there is no conflict of interest not only in conducting research but also in scientific publication.

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