

Evaluating TPACK of Geography Teachers to Support Continuous Professional Development in Yogyakarta Private High Schools

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Abstract

Professional teachers must have adequate TPACK (Technological Pedagogic Content Knowledge) competencies. Research objectives: (1) To assess the level of understanding and application of TPACK by geography teachers based on certification status and school accreditation (2) To reveal the support and obstacles faced by geography teachers in implementing TPACK. This study applied a quantitative descriptive approach using the CIPP (Context, Input, Process, Product) evaluation model. The sample in this study consisted of 40 geography teachers. Based on the quantitative data analysis it was found that the average TPACK score of certified teachers reached 73.25, reflecting a relatively high level of understanding and application. Meanwhile, non-certified teachers have an average score of 53.7 which is in the moderate to low category. In the context aspect showed a significant difference between certified and non-certified teachers, with certified teachers having higher and more stable TPACK scores than non-certified teachers. In the input, it was found that the level of school accreditation influenced the readiness of supporting resources for TPACK implementation. The process evaluation revealed that despite various forms of support, such as facilities, training, and teacher collaboration, the TPACK implementation process still faced obstacles such as infrastructure limitations, low ICT competence, workload, and student readiness. In the product, this study recommends strengthening the continuing professional development program through contextual training, strengthening the teacher community, implementing mentoring, increasing school support, and continuous evaluation.

Keywords: TPACK, CIPP, Geography Teacher, Professional Development

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1. Introduction

In the regulation of the Minister of National Education number 16 of 2007, it is stated that teachers must have the competence to utilize information and communication technology to communicate, develop themselves and the interests of learning (Kemendiknas, 2007). One of the determinants of success in education is the teacher. Teachers in today's era are equipped with teaching methods, how to use information and communication technology. This is the starting point for preparing

professional teachers, a teacher is required to strengthen mastery of science in learning because teacher innovation and creativity in developing learning models, research, and technology-based evaluation is the main scale to improve the learning process (Ananda et al., 2022). In the regulation of the Minister of National Education number 16 of 2007, it is stated that teachers must have the competence to utilize information and communication technology to communicate, develop themselves and the interests of learning (Kemendiknas, 2007). One of the determinants of success in education is the teacher. Teachers in today's era are equipped with teaching methods, how to use information and communication technology. Professional standards for teachers are reflected in competency tests conducted in the form of portfolio assessments. Portfolio assessment is a recognition of teachers' professional experience in the form of an assessment of a collection of documents that describe academic qualifications, education and training, teaching experience, lesson planning and implementation, assessments from superiors and supervisors, academic achievements, professional development work, participation in scientific forums, organizational experience in the field of education and social affairs, and relevant awards (H Kara, 2014). Teacher is required to strengthen mastery of science in learning because teacher innovation and creativity in developing learning models, research, and technology-based evaluation is the main scale to improve the learning process (Ananda et al., 2022).

In Indonesian education, the scope of professional development covers three main aspects: self-development, scientific publications, and innovative works (Kemendikbud, 2021). Through these activities, teachers are expected to improve their professionalism while contributing to the improvement of learning and education quality as a whole. Teachers are required to be able to utilize technology in learning, not only as an auxiliary medium but also as a means of pedagogical innovation. This aligns with findings that teachers actively engaged in technology-based professional development programs demonstrate better ability to integrate learning innovations and adapt to curriculum changes (Avalos et al, 2011).

TPACK teachers knowledge to integrate technology in learning makes learning effective and efficient, professional teachers must have relevant TPACK (Technological Pedagogic Content Knowledge) competencies, because TPACK is included in the scope of the four main competencies that must be possessed by a teacher, namely pedagogic, personality, social, and professional competencies (Suyanto et al., 2020). This condition is reinforced by (Anugrah& Dewi, 2020), who state that teachers' internal readiness, such as motivation, digital literacy, and time management, plays an important role in the successful integration of TPACK, but is often hampered by a work system that burdens teachers with disproportionate administrative tasks. The use of technology in education must be accompanied by a deep understanding of how to effectively incorporate this technology into pedagogy and learning content. Teachers need to develop the learning process in the classroom and continue to improve their ability to design learning, one of which is by understanding the concept of Technological Pedagogical Content Knowledge (TPACK). (Susanti&Nugroho, 2022) stated that institutional support, such as principal commitment, mentoring in technology use, and providing incentives to innovative teachers, are crucial inputs for the successful implementation of ICT-based learning. Schools with C accreditation, despite their enthusiasm for digital transformation, often face challenges such as limited funding, limited access to technology, and a lack of training relevant to the needs of TPACK implementation in the classroom. (Iswahyudi et al, 2022) also revealed that the success of TPACK implementation was greater in schools that fostered a culture of innovation, provided technical support, and integrated training in the real context of learning, not just at the theoretical level.

Continuing Professional Development is an important component in improving teacher quality. The main objective of continuing professional development is for teachers to not only carry out their teaching roles, but also to continuously develop their competencies through reflective, collaborative, and innovative activities. The scope of PKB includes self-development, writing scientific papers, and creating innovations, all of which require mastery of critical thinking,

creativity, and digital literacy skills (Kemendikbud, 2021). This study formulated several main questions: are there differences in the level of TPACK competency between certified and uncertified Geography teachers; to what extent does school accreditation influence the mastery and application of TPACK; what supporting factors and obstacles do teachers face in implementing TPACK in the learning process; and what strategies or recommendations can be developed to strengthen teachers' ongoing professional development. CPD is teacher competency development, which is carried out according to needs, gradually and continuously, to improve professionalism CPD (Nurhidayanti et al., 2024). Teachers who have good TPACK competencies are generally better equipped to create learning innovations, actively participate in technology-based training, and contribute to sharing learning practices through digital media. The level of TPACK mastery significantly influences teachers' involvement in PKB activities, especially the aspects of professional cooperation and the implementation of innovations in the learning process (Ergen, B., & Ergen, 2022).

Based on observations in the field, many certified geography teachers have not been able to integrate technology optimally into the learning process. This may be due to a number of factors, such as the uneven availability of technology infrastructure in various schools, limited training that specifically addresses the application of Information and Communication Technology (ICT) in learning, as well as teachers' difficulties in leaving the conventional methods they have mastered to switch to technology-based learning approaches that require adjustments to new teaching strategies. Based on this background, this study aims to evaluate the extent to which certified geography teachers in private high schools in Yogyakarta City have mastered TPACK and how this evaluation can help determine teachers' needs for a more relevant and targeted Continuing Professional Development program. With this TPACK proficiency evaluation, it is hoped that schools and related institutions can develop professional development programs that focus on the real needs of teachers, so that they can be more relevant and targeted.

The novelty of this study lies in its focus on evaluating the TPACK competencies of certified geography teachers in private high schools in Yogyakarta City using the CIPP (Context, Input, Process, Product) evaluation model. Previous studies have generally evaluated TPACK among public school teachers (Susanto et al., 2020), non-certified teachers (Handayani & Wardani, 2021), or in science subjects in general (Chai et al., 2020). This study differs because: (1) It focuses on certified geography teachers in private schools, a group that is rarely studied but plays a strategic role in supporting equitable education quality. (2) It examines the relationship between TPACK proficiency levels and teachers' actual needs for more relevant and contextual PKB programs. (3) It provides an empirical basis for schools and related institutions to develop more targeted and teacher-need-based PKB programs, which are expected to be more effective than generic training programs. Thus, this study not only enriches the literature on TPACK in the context of geography education but also contributes practically to designing strategies for enhancing teacher competencies through PKB programs oriented toward field-based needs.

This study formulated several main questions: are there differences in the level of TPACK competency between certified and uncertified Geography teachers; to what extent does school accreditation influence the mastery and application of TPACK; what supporting factors and obstacles do teachers face in implementing TPACK in the learning process; and what strategies or recommendations can be developed to strengthen teachers' ongoing professional development.

2. Method

This study uses a quantitative descriptive research design using test and non-test instruments. Quantitative methods are used to make measurements and descriptive methods are used to describe the facts in the field. The data collected is analyzed quantitatively using descriptive statistics so that the results of this study can be illustrated according to the research objectives. This research was conducted at a private high school in Yogyakarta City.

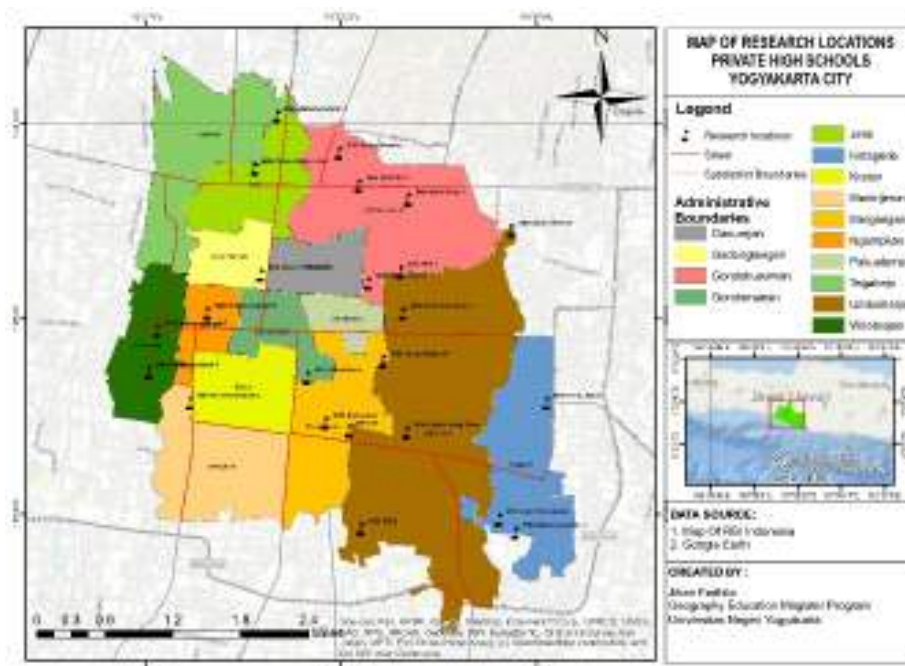


Figure 1. research location map

A. Evaluation Model

In this study, the evaluation model used was the CIPP (Context, Input, Process, and Product) evaluation model. The CIPP evaluation model was chosen because the aspects reviewed in this research model are considered more comprehensive than other evaluation models. There are four aspects of evaluation in the CIPP model, namely context evaluation which includes assessing the level of understanding and application of TPACK by certified and non-certified geography teachers in private high schools in Yogyakarta City. Input assesses the level of understanding and application of TPACK by geography teachers based on school accreditation in private high schools in Yogyakarta City. Process reveals the support and barriers faced by geography teachers in implementing TPACK in private high schools in Yogyakarta City. Product develops recommendations to improve the Continuing Professional Development (PKB) program for geography teachers. The population used in this evaluation research includes all private high school geography teachers in Yogyakarta City.

B. Research Subject

The sampling technique used in this study was purposive sampling. This technique was chosen to obtain samples intentionally based on certain criteria that were considered relevant to the research objectives. The subjects in this study were 40 geography teachers at private high schools in Yogyakarta City. The sample selection criteria included: (1) Geography teachers who actively teach at private high schools (2) Have or do not have teacher certification (3) Willing to fill out the instrument (4) Represent various levels of school accreditation.

C. Data Analysis

This study used descriptive and inferential methods. Descriptive analysis aimed to describe teachers' TPACK. Inferential analysis aimed to test the hypotheses formulated in this study. Descriptive analysis of the test and questionnaire results was conducted to determine: (1) The level of understanding and application of TPACK by certified and non-certified geography teachers in private high schools in Yogyakarta City. (2) To assess the level of understanding and

application of TPACK by geography teachers based on school accreditation in private high schools in Yogyakarta City.

Inferential analysis in this study was conducted with the help of the SPSS program. The data analyzed were assumed to follow a normal distribution and have the same variance, therefore parametric statistical analysis using the Independent Sample T-Test was applied. This test was used to determine: (1) whether there are differences in the mastery and application of TPACK among geography teachers when viewed from the certification status and (2) whether there are differences in the mastery and ability to apply TPACK among geography teachers based on the level of school accreditation.

3. Result and Discussion

A. Result Evaluation Context

Context evaluation in the CIPP model is conducted to explore the needs and understand the background that underlies the program and justification for the implementation of a program. In the context of this study, the context evaluation focused on the level of understanding and application of TPACK by certified and non-certified Geography teachers in private high schools in Yogyakarta City. To assess this aspect, the TPACK scores of the two groups of teachers were measured. The measurement results reflect the level of understanding and application of TPACK in each group as follows:

Table 1. Geography teacher TPACK scores

No.	Teacher Group	Average
1	Certification	73,25
2	Non Certified	53,7

Source: Research Results, 2025

Based on the quantitative data analysis of 20 certified teachers and 20 non-certified teachers, it was found that the average TPACK score of certified teachers reached 73.25, reflecting a relatively high level of understanding and application. Meanwhile, non-certified teachers have an average score of 53.7 which is in the moderate to low category. The score distribution pattern shows that certified teachers tend to have more stable and high scores, while non-certified teachers show a wider variation in scores with a tendency towards lower values.

B. Evaluation Input

The evaluation of the Input aspect in the CIPP model focuses on the availability of resources and the level of readiness that supports the implementation of TPACK, including the quality of educational institutions where teachers work. In this case, the level of school accreditation is used as a benchmark to assess the quality and readiness of the educational environment in supporting the implementation of TPACK by geography teachers. Based on quantitative data from 40 geography teachers spread across various private schools in Yogyakarta City, the TPACK scores were grouped according to the accreditation of the school where they teach as follows:

Table 2. School accreditation

No.	School Accreditation	Number of Teachers	Average
1	A	21	74,88
2	B	13	57,54
3	C	6	42

Source: Research Results, 2025

Based on the table, A-accredited schools show the highest average TPACK score of 74.88, with

a relatively consistent distribution of scores and at a high level. This finding suggests that institutions with A accreditation tend to have better input support, both in terms of facilities, technology integration, and readiness in organizing teacher competency development programs. Meanwhile, schools with B accreditation with an average of 57.54 and C with an average of 42 tend to have limitations in the provision of educational resources, such as access to ICT training, availability of technological devices.

C. Evaluation Process

The process component of the CIPP evaluation model focuses on the implementation of the program at the operational level, including the challenges, approaches, and steps taken during the implementation process. In this study, it is directed at how Geography teachers in private high schools in Yogyakarta City apply TPACK in learning activities, as well as the various forms of support and obstacles they face during implementation in the classroom.

Based on the results of the study, a number of forms of support felt by teachers in implementing TPACK are as follows: (1) Support from the school in the form of providing projectors, internet access, and school policies that encourage the use of technology in learning (2) Support from the government in the form of ICT training and independent curriculum workshops that introduce technology-based learning models (3) Collaboration between teachers both in the form of learning communities and MGMP forums that help exchange good practices in integrating ICT (4) Teachers' personal motivation, especially those who are certified and accustomed to attending training, to continue to innovate in teaching. This finding is in line with the opinion of (Yulianti & Harjono, 2021) which states that the success of TPACK integration is not only determined by formal training, but also by the support of a work environment that facilitates teachers to continue learning and innovating. Schools that actively encourage teachers to engage in professional training and discussions show significant improvements in the quality of ICT-based teaching

The barriers to the implementation of TPACK are as follows: (1) Limited technology facilities especially in B and C accredited schools such as the lack of availability of LCDs, computers, or unstable internet connections (2) Low ICT competence as a teacher especially those who have not been certified or rarely attend training which makes it difficult for teachers to integrate technology into geography materials (3) Administrative burdens and limited time make it difficult for teachers to develop technology-based teaching materials or attend training (4) The diverse readiness of students especially in using digital devices as teaching media is a challenge in TPACK-based learning.

D. Evaluation Product

The Product component in the CIPP evaluation model serves to evaluate the output and impact of a program, both in terms of goal achievement and the benefits felt by the targeted parties. In the context of this research, the product evaluation focuses on the extent to which TPACK has been applied by Geography teachers, and how these results can be used as a reference in formulating recommendations for strengthening the Continuing Professional Development program. The following are recommendations for improving and strengthening the PKB program: (1) Integration of TPACK training in school context-based PKB (2) Strengthening the community of practitioners and MGMP forum (3) Implementation-based mentoring and supervision (4) Strengthening the role of schools in supporting PKB (5) Regular evaluation and feedback on the effectiveness of PKB.

E. Prerequisite Test

1) Data Normality Test

In this study, the way to do the normality test is to use the Kolmogorov Smirnov test. The data from the normality test can be seen in the following table:

Table 3. One-Sample Kolmogorov-Smirnov Test

			Unstandardized Residual
N			40
Normal Parameters ^{a,b}	Mean		.0000000
	Std. Deviation		9.45072341
Most Extreme Differences	Absolute		.191
	Positive		.134
	Negative		-.191
Test Statistic			.191
Asymp. Sig. (2-tailed)			.053 ^c

Source: Research Results, 2025

Based on the Kolmogorov Smirnov test results, the Asymp. Sig. (2-tailed) value of 0.053. This value is greater than the significance level $\alpha = 0.05$, so it can be concluded that the residual data is normally distributed. Thus, the assumption of normality is fulfilled.

2) Data Homogeneity Test

Homogeneity test is conducted to identify whether the variance between data groups is uniform or not significantly different. In this study, the homogeneity test was conducted using Levene's test on the data of teachers' TPACK scores. The data of homogeneity test results can be seen in the following table:

Table 4. Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
TPACK Score Results	Based on Mean	1.352	1	38	.252
	Based on Median	1.307	1	38	.260
	Based on Median and with adjusted df	1.307	1	30.301	.262
	Based on trimmed mean	1.317	1	38	.258

Source: Research Results, 2025

Based on the SPSS results, the significance values in all calculation methods (mean, median, trimmed mean) are above 0.05, so it can be concluded that the data variance between groups is homogeneous or not significantly different. In the context of the CIPP evaluation model, especially in the Input component that evaluates teacher competencies such as TPACK, this homogeneity assumption is important so that comparisons between groups can be made fairly and validly. Thus, the differences that emerge reflect the reality being evaluated, rather than being caused by data irregularities.

3) Hypothesis Test

Hypothesis testing aims to identify whether there is a significant difference between the TPACK scores of certified and non-certified teachers. This analysis was conducted using the Independent Sample T-Test test, by first ensuring that the data met the assumption of equal variance through

the Levene test. Based on the output results from SPSS, the significance value on Levene's Test is 0.252, which is greater than the significance level of 0.05. This indicates that the assumption of homogeneity of variance is met, so the interpretation of the t test results is carried out on the Equal variances assumed line. The t test produced a t value of 6.503 with a degree of freedom (df) of 38, and a significance value (2-tailed) of 0.000. Since the significance value is below 0.05, it can be concluded that there is a significant difference between the TPACK scores of certified and non-certified teachers. The average TPACK score of certified teachers is 73.25, while non-certified teachers have an average of 53.70. This difference of 19.55 points indicates that certified teachers have a statistically significantly higher mastery of TPACK compared to non-certified teachers.

4) Comparison with previous studies

This study is related to several previous studies that also highlight teachers' Technological Pedagogical and Content Knowledge (TPACK) abilities, both in terms of certification, school accreditation, and readiness for 21st century learning. Several studies that examined high school biology teachers using a quantitative descriptive approach found variations in TPACK abilities based on accreditation and school location. Their findings indicate that teachers' mastery of TPACK still varies between adequate and low levels. The similarity between this study and the aforementioned studies lies in the use of a quantitative descriptive approach to evaluate teachers' competencies, while the difference lies in the focus of the subject area, as this study specifically analyzes private high school geography teachers in the city of Yogyakarta.

There are several studies examining the competence of mathematics teachers based on their certification status and emphasizing their readiness to implement TPACK-based innovations. The similarity with this study lies in the shared objective of evaluating teachers' competencies in utilizing TPACK. However, this study differs in terms of focus, as it is directed toward the relationship between TPACK competencies and Continuous Professional Development (CPD), rather than merely readiness or competency profiles.

this study contributes to expanding the TPACK study by explicitly linking it to the continuous professional development of geography teachers. While previous studies have focused more on demographic factors, certification, school accreditation, and readiness for 21st-century learning, this study emphasizes the sustainability of teachers' professional competencies. This provides a new perspective that TPACK evaluation is not only important for measuring teachers' current abilities but also serves as a foundation for formulating strategies for sustainable competency enhancement that are relevant to the challenges of modern education.

F. Discussion

1) Evaluation Context

The research results indicate that teacher certification influences the level of understanding and ability to integrate Technological, Pedagogical, and Content Knowledge (TPACK). The certification program appears to provide access to training, experience, and pedagogical insights that support the application of technology in learning. Teacher certification is not only aimed at obtaining an educator certificate, but it is also hoped that certification will improve teacher performance, determine the suitability of teachers in carrying out their duties as learning agents, increase teacher professionalism, improve the educational process and outcomes, and accelerate the realization of better national educational goals (Maghfur et al., 2022). Law of the Republic of Indonesia Number 14 of 2005 concerning teachers and lecturers states that certification is the process of awarding educator certificates to teachers and lecturers. Certification is a form of recognition from a third party that states that a product, process, management system, or individual has met certain standards. The teacher certification program is a way for the

government to improve the quality of teachers, ensure they have good competencies, and help improve their economic conditions (Arifin, 2019).

According (Mishra&Koehler, 2006), TPACK is an important framework that requires teachers to have a deep understanding of how technology can be used synergistically with pedagogical knowledge and content in specific learning contexts. Certified teachers generally have greater opportunities to access professional training, whether in the form of workshops, seminars, or communities, which strengthen all three aspects of the TPACK framework. Through this contextual evaluation, it can be concluded that the implementation of TPACK needs to take into account the conditions and status of teachers, particularly regarding professional certification. There is a need to develop more intensive training strategies and training for non-certified teachers to narrow the competency gap. Strengthening the certification program can be an integral part of supporting the implementation of a technology-based independent curriculum policy.

The difference in scores indicates that teacher certification status influences their level of mastery of pedagogical technology literacy. Certified teachers generally have greater opportunities to participate in training, gain experience, and receive professional guidance. This fosters a deeper understanding of the integration of content, teaching strategies, and technology utilization. Meanwhile, uncertified teachers tend to lack sufficient training or experience in optimally implementing the TPACK framework. Some of them are not yet accustomed to systematically designing technology-based learning, and some even view technology as merely an addition, rather than a primary element, in the learning process.

2) *Evaluation Input*

This study analyzed data from Geography teachers teaching in private schools with A, B, and C accreditations. The scores showed a significant difference. Schools with A accreditation recorded an average TPACK score of 73.48, which is considered high and relatively stable. This indicates that teachers in highly accredited schools are better prepared and accustomed to integrating technology into their learning. Schools with B accreditation had an average TPACK score of 62.2, indicating a fairly good level of understanding and implementation, although not as optimal as those with A accreditation. Schools with C accreditation showed an average TPACK score of 53.9, with a more diverse distribution of scores that tended to be moderate to low.

These differences in scores indicate that the availability and quality of input varies from school to school. Schools with A accreditation generally have more adequate facilities and infrastructure, such as access to ICT devices (computers, projectors, internet), digital libraries, and regular teacher training and development programs. Furthermore, the school's progressive vision for the digitalization of learning is also an important supporting factor. Conversely, schools with B and C accreditation may still face limitations in terms of learning technology facilities, opportunities for ICT training and TPACK workshops, strategies to strengthen the implementation of a digital-based independent curriculum, and administrative support in the form of mentoring or incentives for teacher professional development.

This difference in scores indicates that the availability of technological facilities and infrastructure, training opportunities, and a school climate that supports learning innovation significantly influence teacher competency in implementing TPACK. Schools with high accreditation tend to provide more structured and systematic ICT training programs, including training based on the independent curriculum and TPACK. Stated that institutional support such as principal commitment, mentoring in technology use, and providing incentives to innovative teachers are forms of input that are crucial to the successful implementation of ICT-based learning. Schools with C accreditation, despite their enthusiasm for digital transformation, often face constraints such as limited funding, limited access to technology, and a lack of training appropriate to the needs of TPACK implementation in the classroom.

3) *Evaluation Proccess*

This difference in scores indicates that the availability of technological facilities and infrastructure, training opportunities, and a school climate that supports learning innovation significantly influence teacher competency in implementing TPACK. (Putri&Surya, 2021) emphasized that the level of accreditation is directly proportional to the availability of educational facilities and the quality of school management, which directly impacts teachers' access to technology-based professional development. In this study, the evaluation process focused on observing how TPACK was implemented in the field by geography teachers at a private high school in Yogyakarta, as well as identifying the various forms of support and obstacles they encountered in their daily teaching activities.

The most influential support for the successful implementation of TPACK includes: (1) Support from school management, in the form of providing technological devices such as LCDs, computers, school internet, LMS platforms, and encouragement to attend relevant training or webinars. (2) Professional development activities such as teacher communities and MGMP forums, which serve as places for sharing practices. (3) A school environment that supports learning innovation, characterized by an open attitude from the principal and fellow teachers towards the use of technology, as well as opportunities for teachers to develop technology-based learning methods. (4) Easy access to digital learning information and materials, whether provided by the government, higher education institutions, or through online platforms such as Google Workspace, Canva for Education, and e-modules from the Ministry of Education and Culture.

These findings are in line with the opinion of (Yulianti&Harjono, 2021), who stated that the success of TPACK integration is not only determined by formal training but also by a supportive work environment that facilitates teachers to continue learning and innovating. Schools that actively encourage teachers to engage in professional training and discussions show a significant improvement in the quality of ICT-based teaching.

4) *Evaluation Product*

The product evaluation focused on the results of TPACK implementation by geography teachers and how these findings can be used as a basis for developing recommendations to improve the Continuous Professional Development (PKB) program. Based on this research, the following are recommendations for improving and strengthening the PKB program: (1) TPACK training needs to be tailored to the characteristics and needs of teachers based on the school's accreditation level. Teachers in B and C accredited schools require basic ICT training and digital learning design, while teachers in A accredited schools can focus on strengthening technology-based innovation and integrating the independent curriculum. This recommendation is in line with (Handayani& Nugroho, 2021) who emphasized that an effective PKB program must be based on the real needs and work context of teachers. (2) The PKB program should encourage the formation of active learning communities, such as MGMP that focus on sharing TPACK implementation practices. These forums can be a means of reflection, collaboration, and sustainability among geography teachers. This is reinforced by (Wicaksono et al, 2022) who stated that an active teacher community is key to continuous learning, because it encourages coaching and peer learning naturally. (3) In addition to training, teachers need direct assistance in implementing TPACK in the classroom, which can be done through a mentoring program between teachers that is constructive and adaptive to technological changes.

According to (Setyawati&Arifin, 2022), collaboration-based mentoring has proven effective in increasing the transfer of technological skills into classroom practice, because it adapts to teachers' learning styles and real needs. (4) Schools are expected to be active supporters of PKB, for example by providing dedicated time for teacher self-development and adequate technological support. This is in line with (Rohimah, S., & Lestari, 2023) who stated that schools that provide space for innovation for teachers and facilitate internal training are able to significantly improve

the quality of ICT-based teaching. (5) The PKB program needs to be evaluated periodically to see its effectiveness in improving the understanding and application of TPACK. This evaluation can be done through teacher competency assessments, classroom observations, or teacher needs surveys. According to (Rahmawati, T., & Prasetyo, 2020), PKB based on regular evaluations not only increases the effectiveness of the program but also makes teachers feel involved and valued in the process of developing their competencies. Thus, the evaluation of the product component emphasizes that improving teachers' TPACK skills cannot be achieved through one-way training alone but requires a comprehensive, contextual, and sustainable approach. These findings provide an important basis for developing a more strategic and impactful PKB program to address the challenges of integrating technology into geography learning in the era of the independent curriculum.

4. Conclusion

As a result of the Context evaluation, it can be concluded that there is a significant difference in the level of understanding and application of TPACK between certified and non-certified Geography teachers in private high schools in Yogyakarta City. Certified teachers showed a higher average TPACK score (73.25), reflecting a relatively strong and consistent understanding and application of TPACK. In contrast, non-certified teachers had a lower average score (53.7) with greater variation in scores, indicating a limited and uneven level of TPACK mastery.

From the results of the Input evaluation, it can be concluded that the level of school accreditation affects the readiness and availability of resources in supporting the implementation of TPACK by Geography teachers. Schools with A accreditation showed the highest TPACK score (74.88), reflecting a more conducive environment in terms of availability of facilities, access to technology, and the existence of professional development programs. Meanwhile, schools with B (57.54) and C (42) accreditation showed lower scores, indicating limitations in terms of infrastructure, ICT training, and support for Curriculum implementation.

The Process Evaluation shows that the implementation of TPACK by Geography teachers in private senior high schools in Yogyakarta City takes place with diverse support, but still faces a number of significant obstacles. The main support comes from the provision of facilities by schools, training from the government, collaboration among teachers through learning communities and MGMP, and high personal motivation of teachers, especially for those who have been certified. However, there are still various barriers that hinder the effectiveness of implementation, such as limited technology facilities in schools with lower accreditation, low ICT competence of some teachers, high workloads, and varying readiness of students in using digital devices.

Product Evaluation, a number of recommendations were made to strengthen and improve the implementation of the ESC program, namely: (1) integrate TPACK training tailored to the school context, (2) strengthen the community of practitioners and MGMP forum as a means of sharing good practices, (3) implement implementation-based mentoring and supervision, (4) increase the role of schools in supporting teachers' professional development, and (5) conduct regular evaluation and feedback to ensure the effectiveness and sustainability of the ESC program.

Even though it has been carried out optimally, this research still has several limitations: (1) the research was only conducted at private high schools in Yogyakarta City so that the results cannot be generalized to other areas with different educational and technological conditions (2) the data was obtained through a questionnaire in a relatively short time so that it is possible that the responses were less objective (3) this research only focused on Geography teachers, so that the findings and recommendations do not represent other subjects at the high school level. Future research is recommended to expand the sample size to include both public and private schools, and to conduct comparisons between regions or cities. Furthermore, future studies could also

examine other subjects to obtain a more comprehensive picture of TPACK implementation at the high school level.

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