



# Training and assistance in the preparation of teaching modules based on technological pedagogical content knowledge (TPACK) for science teachers in Pali District

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ARTICLE INFO	ABSTRACT
<p><b>Article history</b> Received: 2024-12-04 Revised: 2025-04-03 Accepted: 2025-04-07 Published: 2025-04-22</p> <p><b>Keywords</b> TPACK Teacher Training Knowledge Enhancement</p>	<p>This activity aims to provide science teachers in PALI district with insights into Technological Pedagogical Content Knowledge (TPACK)-based learning, train them in the preparation of teaching modules, and assist them in designing TPACK-based learning. The training method consists of four stages: preliminary study, workshop implementation, mentoring, and evaluation. Evaluation through pre-test, post-test, and participant feedback showed a significant increase in teachers' understanding of TPACK. The research results show an increase occurred in all aspects, namely Pedagogical Knowledge (PK) from 3.48 to 3.89, Content Knowledge (CK) from 3.45 to 3.99, Technological Knowledge (TK) from 3.22 to 3.86, Pedagogical Content Knowledge (PCK) from 3.27 to 3.90, Technological Content Knowledge (TCK) from 3.00 to 3.87, Technological Pedagogical Knowledge (TPK) from 3.18 to 3.83, and overall TPACK from 3.12 to 3.89. In conclusion, this activity proved effective in improving teachers' skills in developing and implementing TPACK-based teaching modules. This training needs to be carried out continuously in order to develop teachers' TPACK in the learning process.</p>
<p><b>Kata Kunci</b> TPACK Pelatihan Guru Peningkatan Pengetahuan</p>	<p><b>Pelatihan dan pendampingan penyusunan modul ajar berbasis technological pedagogical content knowledge (TPACK) bagi guru-guru IPA di Kabupaten Pali.</b> Kegiatan ini bertujuan untuk memberikan wawasan kepada guru-guru IPA di Kabupaten Pali mengenai pembelajaran berbasis Technological Pedagogical Content Knowledge (TPACK), melatih mereka dalam penyusunan modul ajar, serta mendampingi mereka dalam merancang pembelajaran berbasis TPACK. Metode pelatihan terdiri dari empat tahapan: studi pendahuluan, pelaksanaan workshop, pendampingan, dan evaluasi. Evaluasi melalui pre-test, post-test, dan umpan balik peserta menunjukkan peningkatan signifikan pada pemahaman guru terkait TPACK. Peningkatan terjadi pada seluruh aspek, yaitu Pedagogical Knowledge (PK) dari 3.48 menjadi 3.89, Content Knowledge (CK) dari 3.45 menjadi 3.99, Technological Knowledge (TK) dari 3.22 menjadi 3.86, Pedagogical Content Knowledge (PCK) dari 3.27 menjadi 3.90, Technological Content Knowledge (TCK) dari 3.00 menjadi 3.87, Technological Pedagogical Knowledge (TPK) dari 3.18 menjadi 3.83, serta keseluruhan TPACK dari 3.12 menjadi 3.89. Kesimpulannya, kegiatan ini terbukti efektif dalam meningkatkan keterampilan guru dalam menyusun dan mengimplementasikan modul ajar berbasis TPACK.</p>

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## INTRODUCTION

In a new era, the rapid globalization and evolution of digital technology bringing significant changes. The changing times always demand changes in all fields, including education. Technological advances are actually in accordance with the progress of human civilization which raises a series of new challenges that need to be addressed carefully and

systematically. These changes have an impact on the demands for the quality of education and will certainly have an impact on the quality of teacher education (Anwar et al., 2024).

As a form of adaptation to change, various innovations have been carried out. The latest innovations can emerge from various sources but to improve the learning process the teachers themselves are able to change it (Wulandari et al., 2023). A teacher must be able to innovate with new things. Innovation can not only be obtained through formal education, but can also be obtained through trainings to support continuous professional improvement (Kalyani & Rajasekaran, 2018). The professional development of teachers must take place continuously and throughout life, at least from the time of the student until the end of his professional career. The development of technology requires teachers to innovate to be able to present learning that utilizes technology. Therefore, teachers must master technology and have the competence to utilize technology in learning. The ability of teachers to design and implement learning is influenced by 3 components, namely content mastery, pedagogy and technology (Koehler et al., 2015). The integration of these three components is called TPACK.

Based on the results of a survey of teachers who participated in the PPG program in office, the reality is that in the field almost 90% of teachers have not been innovative, their TPACK ability is still very minimal, this problem is raised in this study. Teachers tend to be busy with teaching without paying attention to the technology, content and pedagogy they acquired while in formal education (Tondeur et al., 2019); (Lixia & Choi, 2024). As has been assessed by several researchers, the use of technology variants in learning is still very few. Minimal use of technology shows that digital literacy is still lacking (Guggemos & Seufert, 2021) which of course affects teachers' Technological Pedagogical Content Knowledge (TPACK) ability. TPACK's ability is greatly influenced by digital literacy (Pondee et al., 2021); Pehlevan & Ünal, 2024); Fahadi & Khan 2022); Backfisch et al., 2021)). TPACK is a development of PCK that has been better known before, as a key element of the learning process (Anwar et al., 2016; Irwanto 2021; Nilsson, 2024), by adding technological elements to TPACK (Mishra et al., 2016).

TPACK serves as a useful conceptual framework for thinking, analyzing, and evaluating that teachers must know in order to integrate technology into teaching, but ultimately TPACK must be understood as a framework for how best teachers develop this integrated knowledge (Ling Koh et al., 2014); Sihombing et al., 2021). As with PCK, of course, TPACK's ability will also develop, referring to the results of research that has been conducted previously that a teacher's PCK will develop with experience, the development pattern can be categorized into three categories of PCK, namely Pre PCK, Growing PCK and Maturing PCK (Anwar et al., 2014). Based on these findings, TPACK's capabilities can also be categorized and improved. As it was concluded by number of experts that TPACK's ability can be improved (Lachner et al., 2021); Kasi et al., 2022). TPACK of good teachers will affect the quality of teacher teaching which of course has an impact on improving student learning outcomes and will further affect the quality of education. Therefore, it is necessary to provide training and assistance to teachers in designing learning in teaching modules based on technological pedagogical content knowledge.

The teaching module designed is a teaching module based on TPACK so that teachers can apply the right strategies and technology related to the content of the material to be taught. Related to the above, the target audience in this activity is a group of Science Teachers in the Junior High School Education unit in PALI district Based on initial observations, the information that teachers have about TPACK-based learning is still limited. This is possible because many teachers do not follow the development of technology and study the characteristics of the material and the learning methods/models that will be applied. Geographically, PALI district is one of the districts in South Sumatra that has a long distance from training centers such as those in the national and provincial capitals.

This training activity will involve lecturers in accordance with their fields. In addition, this activity will also involve students who take it as a form of student MBKM activities. Thus, it is very important to carry out this service activity in the form of training and assistance in the preparation of differentiated learning-based teaching modules in the Independent Curriculum. The chosen learning phase is phase D in the subject of Natural Sciences because it is at the teaching level in Junior High School. This training activity should be carried out continuously because it supports the Sustainable Development Goals (SDGs) achievement program, especially goal number four regarding improving the quality of education (Aina et al., 2023; Camilleri & Camilleri, 2020). Sustainable and continuous professional development equips teachers with up-to-date pedagogical strategies and technological skills, which are essential in adapting to the evolving demands of 21st-century education (Srivastava, 2023). Moreover, embedding the TPACK framework into teacher training enhances their ability to integrate technology meaningfully into the curriculum, thereby fostering inclusive and

equitable quality education (Hamzah et al., 2024; Zaenab et al., 2024). This activity can improve teacher competence in teaching, especially in integrating Content, pedagogy and technology.

## METHOD

The method carried out in this service uses four stages, which are as follows:

Phase I, Preliminary Study.

At this stage, the activities carried out by the service team include:

- Conduct a literature study to examine problems that will be solved through service activities.
- Conducting data collection in the form of interviews and distributing questionnaires about teachers' knowledge about differentiated teaching modules in the Independent Curriculum
- Preparation of training materials by the facilitator.

Phase II, Implementation.

At this stage, a series of training activities were carried out consisting of:

- Workshop on the preparation of TPACK-based teaching modules. At this stage, teachers are given knowledge and understanding first about the teaching module and its criteria then about the teaching module for TPACK-based
- The facilitator will train teachers' skills in preparing lesson plans in the form of TPACK-based learning teaching modules. This activity is intended so that teachers can get experience and feedback on the material during the simulation.

Phase III, Assistance and Guidance.

At this stage, the activities carried out are:

- Fostering and assisting teachers on an ongoing basis in the preparation of TPACK-based teaching modules
- Guiding teachers in schools

The detailed scheme of implementation of the activity method can be seen in Figure 2 below:

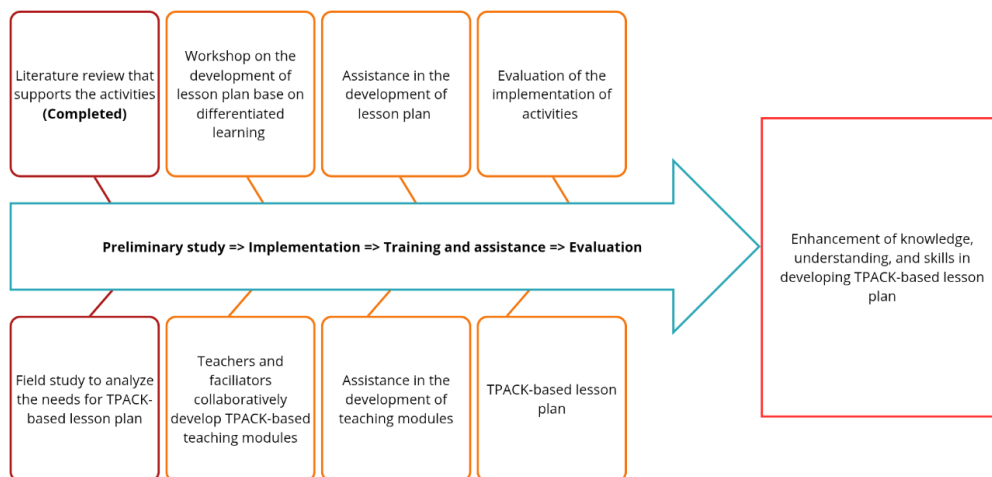


Figure 1. Scheme for the implementation of activity methods

### Target Audience of Service

The target audience in this service activity is 20 junior high school teachers who are members of MGMP OKU Selatan. Through this activity, the target audience is expected to be able to:

- Producing pedagogic and professional skills of teachers in preparing learning tools in the form of differentiated learning-based teaching modules in the Independent Curriculum which ultimately supports the learning process of students in acquiring knowledge
- Produce learning facilitators from teachers so that teachers who have participated in training can teach or transfer the knowledge and skills they have acquired through training to other teachers in schools.

### Evaluation Design

At this stage, the activities carried out are:

- Monitoring

- b. Conduct an evaluation
- c. Conducting follow-up efforts from the results of the evaluation.

The evaluation was carried out through:

1. Pre-test and Post-test related to TPACK-based Teaching and Learning Module materials
2. Task for the Preparation of TPACK-based Teaching Modules in Phase D (Junior High School Level) for Natural Sciences.
3. Questionnaire of participant feedback on training materials and programs. The questionnaire grid of trainees' understanding of the training material can be seen in Table 3. The questionnaire grid of feedback of trainees on training activities can be seen in Table 4.

The activity observation sheet is used as an observation reference in knowing the shortcomings during the implementation of service. The results of this observation sheet are then analyzed, the reasons and causes of this to ultimately plan a service solution in the future.

Table 3. Table of Trainees' Understanding of Training Materials

No	Aspects	Score	Interpretation
1.	Teachers' knowledge and understanding of the phases and learning outcomes to design teaching modules	3	Good
		2	Enough
		1	Less
2.	Teachers' knowledge and understanding of the objectives and flow of learning objectives to design teaching modules	3	Good
		2	Enough
		1	Less
3.	Teachers' knowledge and understanding of differentiated learning	3	Good
		2	Enough
		1	Less
4.	Teachers' knowledge and understanding of TPACK-based teaching modules	3	Good
		2	Enough
		1	Less

Table 4. Questionnaire Grid of Trainees' Feedback on Training

Aspects	Indicator	Highest Response	Average
Quality of Material Delivery by Resource Persons			
Mastery of the Material	5= Very Good, 4= Good, 3=Enough, 2= Not Good, 1= Very Bad		
Delivery	5= Very Good, 4= Good, 3=Enough, 2= Not Good, 1= Very Bad		
Training Programs			
Suitability of Training Themes	5= Very Good, 4= Good, 3=Enough, 2= Not Good, 1= Very Bad		
Fun Training Atmosphere	5= Very Good, 4= Good, 3=Enough, 2= Not Good, 1= Very Bad		
Experience gained	5= Very Good, 4= Good, 3=Enough, 2= Not Good, 1= Very Bad		

The grid of pretest and posttest evaluation sheets is presented in the Appendix section. The activity observation sheet is used as an observation reference in knowing the shortcomings during the implementation of service. The results of this observation sheet are then analyzed, the reason for this to finally plan a service solution in the future. The table of assessment categories according to (Arikunto, 2006) is as follows:

Table 5. Categories Assessment

Range	Category
80-100	Very good
66-79	Good
56-65	Enough
40-55	Less
30-39	Fail

## RESULTS AND DISCUSSION

### Training and mentoring activities

Before entering the training materials and activities, teachers are asked to take a pre-test to determine their initial abilities.



Figure2. Training and mentoring activities

The teachers involved were explained about TPACK and its importance in learning, and then the teachers were given examples of TPACK-based teaching modules and analyzed sample documents. Furthermore, the teachers were guided to make a TPACK-based teaching module; the activity lasted for seven hours, and then the teachers were asked to complete their teaching modules at their respective homes for one week, which was followed by exposure to the results and

corrected directly the following week. The exposure activity lasted several days, considering that the implementation time took quite a long time for each teacher.

### Respondent Demographic Profile

The data below was obtained through the distribution of questionnaires to respondents (Riyanti et al., 2023), namely junior high school science teachers in PALI district. The identity of teachers who are respondents in service can be seen in the table.

Table 6. Respondent's Profile

No.	Initial	Age	Teaching Experience	Alumni	Institution
1.	A	45 Tahun	21 Tahun	Univ. Muhammadiyah Palembang	SMPN 2 Penukal
2.	ADP	24 Tahun	02 Tahun	UIN Raden Fatah Palembang	SMP YPIP Talang Ubi
3.	AF	26 Tahun	05 Tahun	S1 Pendidikan Fisika Unsri	SMPN 4 Penukal
4.	AP	37 Tahun	06 Tahun	Universitas Sriwijaya Pend. Fisika	SMPN 8 Talang Ubi
5.	AEP	23 Tahun	02 Tahun	Universitas Sriwijaya	SMP YKPP Pendopo
6.	BT	29 Tahun	07 Tahun	Pend. Fisika STKIP Surya Tangerang	SMPN 11 Talang Ubi
7.	DN	31 Tahun	10 Tahun	Univ. Muhammadiyah Palembang	SMPN 6 Penukal
8.	EK	47 Tahun	20 Tahun	Univ. Muhammadiyah Palembang	SMPN 3 Penukal
9.	EM	54 Tahun	27 Tahun	Universitas Sriwijaya	SMPN 2 Penukal
10.	EN	33 Tahun	08 Tahun	Universitas Ahmad Dahlan	SMPN 5 Talang Ubi
11.	ES	39 Tahun	18 Tahun	FKIP Biologi Muhammadiyah Palembang	SMPN 10 Talang Ubi
12.	EN	45 Tahun	10 Tahun	MIPA Kimia Unsri	SMPN 13 Talang Ubi
13.	HS	30 Tahun	05 Tahun	Univ. PGRI Palembang	SMPN 3 Talang Ubi
14.	IS	30 Tahun	05 Tahun	S1 FKIP Fisika Univ. PGRI Palembang	SMPN 1 Talang Ubi
15.	IH	29 Tahun	05 Tahun	S1 Pend. Kimia Univ. Lampung	SMPN 7 Penukal
16.	KS	28 Tahun	04 Tahun	Univ. Muhammadiyah Palembang	SMP YPIP Talang Ubi
17.	M	54 Tahun	32 Tahun	UT	SMPN 13 Talang Ubi
18.	NS	24 Tahun	01 Tahun	UIN Raden Fatah Palembang	SMP PGRI Talang Ubi
19.	N	31 Tahun	09 Tahun	S1 FKIP Fisika Unsri	SMPN 6 Talang Ubi
20.	P	32 Tahun	04 Tahun	Universitas Sriwijaya	SMPN 2 Talang Ubi
21.	RS	46 Tahun	19 Tahun	S1 Pertanian Universitas Sriwijaya	SMPN 9 Talang Ubi
22.	RNW	27 Tahun	04 Tahun	Univ. Muhammadiyah Palembang	SMPN 7 Talang Ubi
23.	SDY	35 Tahun	12 Tahun	FKIP Pend. Biologi Universitas Sriwijaya	SMPN 4 Talang Ubi
24.	TY	41 Tahun	19 Tahun	Univ. Muhammadiyah Palembang	SMPN 12 Talang Ubi
25.	YM	43 Tahun	19 Tahun	FKIP Fisika Univ. PGRI Palembang	SMPN 1 Penukal
26.	Y	39 Tahun	10 Tahun	Pendidikan Kimia UNSRI	SMPN 5 Penukal

### Questionnaire Data Analysis (Pre-Test and Post-Test)

The initial stage to find out the teacher's TPACK ability is the distribution of questionnaires to junior high school science teachers. The initial questionnaire is carried out in the form of Pre-Test and the final questionnaire is carried out in the form of Post-test. The questionnaire consisted of 33 questions consisting of 6 statements for the Pedagogical Knowledge aspect, 4 statements for the Content Knowledge aspect, 7 statements for the Technological Knowledge aspect, 7 statements for the Pedagogical Content Knowledge aspect, 2 statements for the Technological Content Knowledge aspect, 4 statement items for the Technological Pedagogical Knowledge aspect, and 3 statement items for the Technological Pedagogical and Content Knowledge aspect.

Table 7. Results of TPACK Ability Questionnaire Analysis for Junior High School Science Teachers in PALI Regency

TPACK Indicators	PRE-TEST	Criteria	POST-TEST	Criteria
PK	3,48	Good	3,89	Good
CK	3,45	Good	3,99	Good
TK	3,22	Enough	3,86	Good
PCK	3,27	Enough	3,90	Good
TCK	3,00	Enough	3,87	Good
TPK	3,18	Enough	3,83	Good
TPACK	3,12	Enough	3,89	Good

From the results of table 7 which contains the results of the questionnaire and interpretation of the Pre-Test and Post-Test for seven aspects of TPACK. It can be seen in the table that there is an increase in scores in each of the existing aspects. Based on this, it indicates good results with training in improving the TPACK ability of junior high school science teachers in PALI Regency.

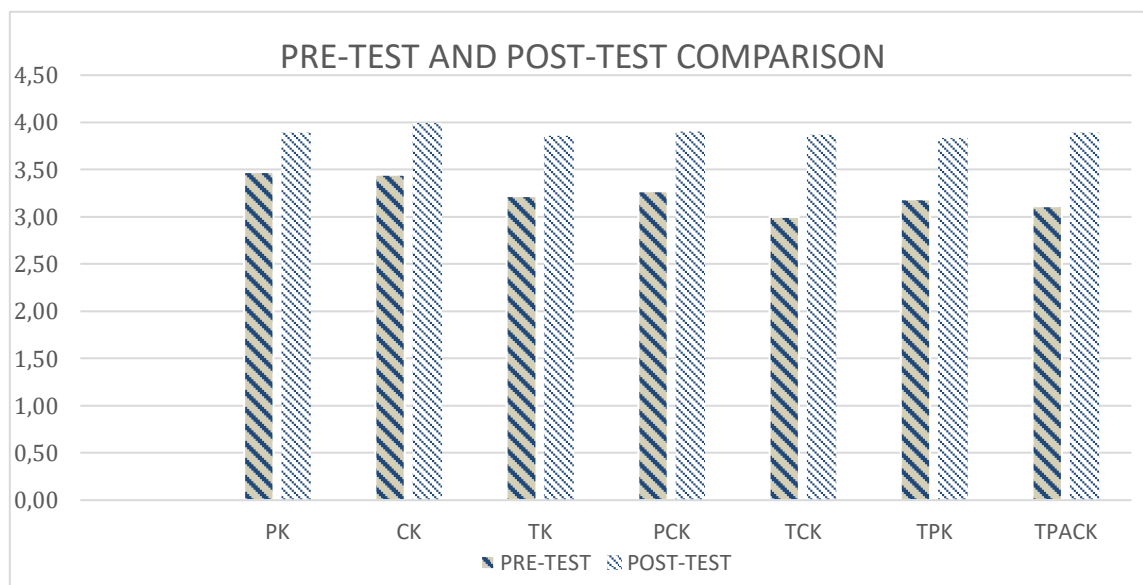


Figure 3. Comparison Diagram of Pre-Test and Post-Test

Figure 2 shows that there is a different and very significant comparison. These differences show that each aspect has an increase in the results of the questionnaire scores obtained.

The benefits obtained include improving teachers' pedagogic and professional skills in preparing TPACK-based teaching modules. The increase in knowledge, understanding and ability of teachers in compiling TPACK-based teaching modules, and through this activity is also expected to ultimately have an impact on students so that students can also be able to follow the era of technological advancement in the field of education (Anwar, 2018).

At the initial stage of the activity, namely a preliminary study with the distribution of a questionnaire in the form of measuring the teacher's TPACK ability which is considered a Pre-Test. The Pre-Test is seen to see the knowledge and ability of teachers towards TPACK. The results of the Pre-Test were obtained that the number of each aspect had the criteria of Medium. Each of these aspects consists of PK with an average of 3.48 with Good criteria, CK with an average of 3.45 with Good criteria, TK with an average of 3.22 with Medium criteria, PCK with an average of 3.27 with Medium criteria, TCK with an average of 3.00 with medium criteria, TPK with an average of 3.18 with medium criteria, and TPACK with an average of 3.12 with moderate criteria. This shows that the ability and knowledge of junior high school science teachers in PALI is still minimal. Therefore, it is necessary to have training and preparation of TPACK-based teaching modules to improve teacher competence (Anwar et al., 2024; Chai et al., 2013; Dong et al., n.d.; Koh et al., 2017). After the Pre-Test stage is carried out, it will be continued to prepare the material from the activity.

At the implementation stage, this workshop aims to provide teachers with an in-depth understanding of the preparation of teaching modules, especially those based on the TPACK (Technological Pedagogical Content Knowledge) approach. Teachers will be given basic knowledge about the concept of teaching modules, including the criteria that must be met in their preparation. In addition, they will also be introduced to the principles of TPACK-based teaching modules, which effectively integrate technology, pedagogy, and content in the learning process. The TPACK approach has been shown to improve teachers' competence in integrating educational technology, which in turn improves student engagement and learning outcomes. Furthermore, teacher training that focuses on TPACK development enables teachers to be more effective in designing and implementing online and blended learning (Philipsen et al., 2019); (Lisa et al., 2021). Furthermore, the Mentoring and Guidance Stage, the facilitator will train the teachers' skills in designing a lesson plan using TPACK-based teaching modules. In this activity, teachers will have the opportunity to practice directly, prepare teaching modules, and conduct learning simulations. The goal is for teachers to gain practical experience and constructive

feedback (Khairani et al., 2024), so that they can improve their competence in compiling and implementing TPACK-based teaching modules in the classroom.

In the Mentoring and Guidance stage, several digital platforms were introduced to support TPACK-based learning. These platforms include Google groups which are commonly used in learning to carry out online discussions. Through Google Groups, teachers can hold discussion forums that allow students to interact, exchange ideas, and complete assignments collaboratively, supporting the TPACK approach by integrating technology in teaching and learning activities (Papanikolaou et al., 2017; Benson & Ward, 2013; Mutiara Nabilah et al., 2023). In addition, there are google sites which are a medium in integrating technology for learning devices. By leveraging Google Sites, teachers can organize learning materials in a format that is easily accessible to students, including teaching modules, assignments, and other resources. This allows the creation of an E-Learning platform that supports distance and hybrid learning, providing flexibility for students to learn anytime and anywhere (Liu & Yu, 2023); (Mujianto & Suryadhianto, 2025).

At the evaluation stage in this training program, it will be carried out through several methods. The post-test will be used to measure the final understanding of junior high school science teachers in PALI regarding TPACK-based teaching and learning module materials. Second, participants will be given the task of compiling a TPACK-based teaching module in Phase D (junior high school level) with a focus on Natural Science subjects. This task aims to apply the theory that has been learned in the form of real practice. In addition, participants will also be asked to fill out a feedback questionnaire related to training materials and programs. This questionnaire will be used to evaluate the level of understanding of participants in the material presented, as well as provide input on the effectiveness and quality of training.

The results of the Post-Test show that there is an improvement in aspects of TPACK. This increase can be seen from the results of the data, namely each of these aspects consists of PK with an average of 3.89 with Good criteria, CK with an average of 3.99 with Good criteria, Kindergarten with an average of 3.86 with good criteria, PCK with an average of 3.90 with good criteria, TCK with an average of 3.87 with good criteria, TPK with an average of 3.83 with good criteria, and TPACK with an average of 3.89 with good criteria. This shows that the training carried out has a good effect on the ability of junior high school science teachers in PALI. It is hoped that through this training teachers can improve their teaching methods which will have an impact on improving student achievement, which of course will improve the quality of the teaching and learning process in the classroom (Bakri et al., 2021). Structured and sustainable teacher training has been proven to strengthen teachers' pedagogical competence and professionalism in managing learning (Darling-Hammond et al., 2017). Increasing teaching and learning activities in the classroom shows an increase in the quality of education, which is one of the Sustainable Development Goals (SDGs), namely improving quality education, which is the fourth goal of the SDGs. Organizing inclusive, quality, and equal education to be accessible to everyone, and supporting lifelong learning opportunities for everyone

## CONCLUSION

Training and assistance in the preparation of TPACK-based teaching modules for junior high school science teachers in PALI Regency has improved teachers' ability to design more modern and effective learning. Training and mentoring carried out in a sustainable manner will certainly have a better influence on TPACK teachers. The results of the Pre-Test and Post-Test showed improvements in all aspects of TPACK, including pedagogical knowledge, content, and technology. This means that the training has successfully helped teachers understand and use the TPACK approach well in classroom learning.

In addition, the introduction of digital platforms such as Google Groups and Google Sites helps teachers integrate technology in learning effectively. By using this platform, teachers can create more interactive and flexible learning, which will have an impact on students.

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