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Teachers Learning in Technology-Ethnoscience Professional Development and Its Impact on TPACK

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Abstract: This study investigates teachers' learning in technology-ethnoscience professional development for 3 months and its impact on science teachers' TPACK in East Nusa Tenggara (NTT)-Indonesia. These secondary school science teachers participate in PD that focuses on communication of information technology and ethnoscience-based materials and their applications in designing and conducting classroom instruction. Five science teacher instruments (n=28) were used, i.e. TPACK test questions, lesson plan analysis rubric, teaching observation sheets, response questionnaires and interview guides. Data is collected before, during, and after program implementation which is carried out every week. Descriptive statistics and Paired Sample T-Test were used for analysis. It was found that teachers' TPACK increased after studying in the program with significant benefits. In addition, the ability to design and implement learning changes to be more oriented towards technology-ethnoscience integration, but the benefits are not significant for all science teachers. This study suggests that teachers' PD programs in the future need to consider aspects of integrating technology in learning and the process is carried out not only when the program is run, but continues every day in class so as to create habits for science teachers. Indonesia currently needs more longitudinal PD to ensure that TPACK is integrated in science teaching and its usefulness for student learning outcomes.

Keywords: Teachers learning; Technology-ethnoscience professional development; TPACK.

Introduction

Teacher is one of the intellectual actors who are recognized as having a knowledge base and a set of skills developed during their teaching activities (Fernandez, 2014; Azhar et al., 2022). The growing awareness of teachers is the main key in providing students with a solid foundation for further development in terms of attitudes, knowledge and skills (Snoek et al., 2018). Science teachers, for example, are required to be able to create student-centered learning and play a good role in the organization of lessons in class (Sjoer & Meirink, 2015). Science teachers must also be able to design topics that are relatable to students' daily lives which are expected to produce meaningful learning for the students (Kavanagh et al., 2019).

It is recognized that teachers have a role in managing the classroom and can produce meaningful learning for students. This recognition, among other things, led to an increase in the number of Professional Development (PD) programs that brought about changes in teachers' knowledge and skills in improving their instructional practices which could ultimately improve student learning outcomes (Sgouros & Stavrou, 2019). In this era PD programs focus on training teachers to use new technologies or to use them to support classroom activities (Hew & Brush, 2007). Research reveals that teachers are very enthusiastic about new technologies they find during the program and they design lessons using these new tools in their classrooms, such as using laptops, downloading applications related to instructional media, and Youtube (Dalal et al., 2017).

Furthermore, the effective use of the ethnoscience approach in PD is also explained. Research describing context-based professional development for cultural diversity in school clusters in Portugal suggests that there is a need for a frame to be redirected to the cultural diversity of a place (Szelei , Tinoca & Pinho, 2019). In

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addition to maintaining the culture in an area to be preserved, ethnoscience approach in a program where in the process cultural knowledge associated with scientific concepts can enrich learning materials (Dwianto et al., 2017). Teachers will have more interest when analyzing and designing culture-based science instruction because the activities becomes meaningful according to the context of the life they experience so that it is believed to improve student learning outcomes. In addition, the curriculum content in the future needs to pay attention to the cultural approach because it is related to students' daily lives so that they can improve students' scientific literacy (Dewi, Khery & Erna, 2019). This approach can be carried out in the province of East Nusa Tenggara (Nusa Tenggara Timur, henceforth NTT) which has the potential for traditional culture such as houses, arts (music and dances), clothing, ceremonies and games.

In the context of the East Nusa Tenggara (NTT) region, it was found that in average, teachers' abilities to integrate technology into science instruction are still low (Nasar & Daud, 2020). In addition, the results of observations and interviews of teachers admitted that they had never used local scientific resources in explaining science material. With this in mind, we investigated the usefulness of technology-ethnoscience professional development for teachers' Technological Pedagogical Content Knowledge (TPACK) in terms of understanding/knowledge, skills in designing and implementing instructions. The research questions in this study are as follows: (1) How is the change in teacher learning in the TPACK component after 3 months of participating in the program?; and (2) How useful is the teacher's ability to design and implement instruction in the TPACK component?

Method

This research was conducted on science teachers and students at public and private junior high schools in Nagekeo Regency, East Nusa Tenggara Province, Indonesia, close to Timor Leste and Australia. The teachers are representatives of each sub-district (7 sub-districts), in which each sub-district is represented by 3-5 teachers. 32 teachers teaching science in Grade 7-9 voluntarily participated in this study. Among them, four teachers left the study after the initial stage of the study, reducing the total number of participants to 28 teachers. All research activities have been approved by the principal and carried out in accordance with the administrative and ethical requirements of each school. Throughout the study, identification codes were used instead of their names to ensure participant confidentiality.

Technology ethnoscience professional development is carried out for three months with a total of 20 hours for each month. Four training modules developed by researchers are used as a guide. The first module focuses on explaining the nature of science instruction and because the direction of science material is related to the Nagekeo culture, there is also an explanation regarding its relationship. The second module focuses on technology in science instruction which explains the development of technology in education, technology as content in science instruction, and technology as a medium in science instruction. The third module focuses on science instructional models. The last module is related to the development of technology and culture-based learning activities along with examples of lesson plans.

The research stage begins with the science teacher receiving introductory material related to the importance of integrating technology and the use of local science by university lecturers, participants taking the TPACK ability test and submitting the lesson plans that they have made so far. Participants then study the module, analyze the concept of science in culture and adapt it to basic competencies, and develop a technology and culture-based science lesson plan. In the final stage, four teachers were selected to carry out class instructions for four consecutive weeks using the lesson plans that had been developed before. After the teachers completed the lesson for each week, an evaluation related to the learning is carried out. Next, the researcher conducted TPACK test as a final test after the TPD program, along with teacher interviews and questionnaires.

Data for science teachers was collected using five instruments, i.e. TPACK test questions, lesson plan analysis rubric, teaching observation sheets, questionnaires and interview guides. The test questions consist of 5 items to see science teacher's TPACK knowledge, i.e. the measurement of skills in using technology that is relevant to pedagogy and teaching material, which is assessed using a rubric of scales 1-3. Lesson plan analysis rubric and classroom observation sheet consist of 5 sub-indicators of the TPACK component and use a Likert type modification with four answer options: (1) strongly disagree, (2) disagree, (3) agree, (4) strongly agree. The teacher's questionnaire and interview guide consist of 2 components, i.e. the benefits and results received by the teacher.

In this study, two analysis are used. First, to understand the impact of the program on teachers' TPACK, descriptive statistics were measured for the results of teachers' TPACK tests before and after the program. The results are presented in tabular form showing the increase in teachers' TPACK. Furthermore, an analysis was also carried out to investigate the usefulness of the program on the skills of teachers to design and conduct instruction on TPACK indicators, also to investigate the relationship between teachers'

TPACK and their skills in designing and implementing classroom instruction on TPACK indicators.

Result and Discussion

Teacher learning in technology-ethnoscience and TPACK Competence

In the current era of technological development, TPACK is knowledge that must be possessed by a teacher. In addition to knowledge of how to integrate pedagogy and content (PCK), it is important to add technological knowledge as knowledge that teachers must have (Mishra & Koehler, 2006). The results of descriptive statistical test of science teachers' TPACK before and after attending PD are presented in Table 1 below.

Tabel 1. The results of the statistical test of science teachers' TPACK improvement

Data	Result of TPACK Test	
	Pretest	Postest
Number of teachers (N)	28	28
Mean	39.89	88.24
Standard Deviation	2.74	8.87
Normality test	0.200 (Normal)	0.200 (Normal)
Homogenity test	0.000 (Not Homogeneous)	
Paired Sample T-Test	0.001 (Significantly different)	

Table 1 shows that there is a significant difference between the average test results of pretest participants (39.89%) and posttest (88.24%) in the results of the significance test of teachers' TPACK test which means that there is a benefit of PD for increasing the TPACK of science teachers. Research shows that teachers have not been able to integrate technology, pedagogy and regional/local content into classroom instruction (Riandi et al., 2019). After participants took part in the training program, the average TPACK test results increased, meaning that technology-ethnoscience PD gave positive results in which participants were able to integrate technological knowledge with pedagogical and content knowledge.

The technology referred in this PD is that participants, together with researchers and other science teachers, use the online Zoom Cloud Meetings application to analyze the concept of science in Nagekeo culture, analyze the suitability of basic competence, design lesson plans based on the evaluation of classroom instruction, and refer to the teacher training module to design instructional activities by utilizing technology. Incorporating technology in the PD program has the advantage that it can improve teachers' technological knowledge over time, pedagogical beliefs about scientific inquiry, and interest in the PD program (Lee et al., 2017). Several participants mentioned that they can design instructional activities by utilizing technology such as starting to think about using laptops and LCDs to find information and also create youtube content.

Ethnoscience in PD is carried out by utilizing local science in Nagekeo district, NTT, and then linked to science subject matter. Participants analyze scientific concepts in local science as well as all traditional rituals that can be explained scientifically. The analysis results are then linked to science material in basic competence to further design a lesson plan for science instruction in culture-based classes. One of the participants mentioned that:

"…It turns out that cultural activities in Nagekeo can be integrated into the instructional activities. I had never known that culture could be linked to science instruction. I am very motivated because there is something new to learn, which is the material relationship with the culture that they have…"

In addition to preserving culture in the area, ethnoscience approach in a program can enrich learning materials, because in the process cultural knowledge is associated with scientific concepts (Dwianto et al., 2017).

The effects of Teacher learning in technology-ethnoscience PD on their ability to design and implement instructions in the TPACK component

Tabel 2. The average score of science teachers' lesson plan analysis on the TPACK indicator

Sub Indicator	Percentage Score (%)	
	Before PD	After PD
The suitability of the technology use, the choice of approach to the material	35	93.7
The suitability of technology use, determining the model and material	37.5	100
The suitability of technology use, the selection of media and material	25	100
The suitability of technology use, selection of teaching method and material	25	93.7
The use of technology that is relevant to the way it is taught, in accordance to the material in the context of the Nagekeo culture	25	93.7
Mean	29.5	96.25

The analysis result in Table 2 explains that prior to the training, TPACK ability of science teachers in designing lesson plans was still low (29.5%), especially in science instruction which was associated with a cultural context with the use of technology in it. After participating in PD, the teachers experienced an increase in the five TPACK sub-indicators (95.8%). Science teachers have been able to utilize technology in instructional activities and the use of this technology is also relevant to approaches, models, media, methods and also the material being taught. The material taught has also been linked to local science, i.e. the Nagekeo district. The study revealed that the science teachers' TPACK increased after participating in the teacher professionalism development program (Rienties et al., 2013).

The implementation of classroom instructions by science teachers is directed at the TPACK indicators which are carried out for the four teachers. The TPACK indicators are divided into four sub-indicators, i.e. the suitability of the use of technology, the approach to the material (I1), the suitability of technology use, the use of the model with the material (I2), the suitability of the use of technology, the media with the material (I3), the suitability of the use of technology, the method with the material (I4) and the use of technology relevant to how to teach it and according to the material in the context of Nagekeo culture (I5).

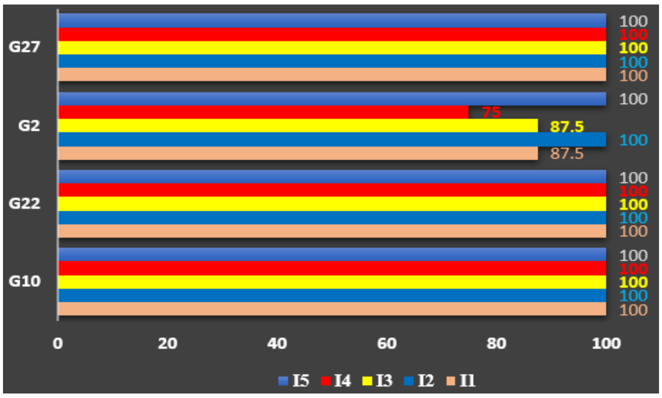

Figure 1. The results of the observation of the implementation of the TPACK indicator instruction

Figure 1 shows that science teachers have been able to implement culture-based instructions by utilizing technology as indicated by good teacher's TPACK abilities (average score 75-100). Teachers can take advantage of technology such as showing videos of cultural activities, making videos on YouTube so that they can motivate students to learn. Teacher G27, for example, made his own video related to Ndai/hunting cultural activities and uploaded it to YouTube. The video was then played as an initial stimulus for students' learning activities.

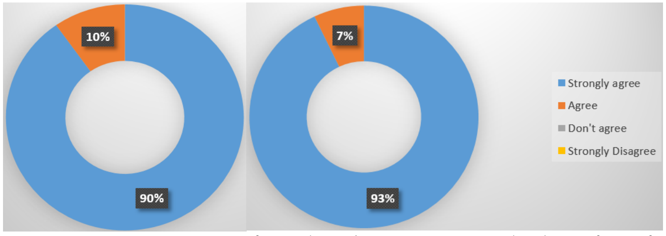

Figure 2. Percentage of teachers' responses to the benefits of the program and new knowledge gained after participating in PD

From Figure 2 it can be explained that 90% of science teachers strongly agree and 10% of science teachers agree that the PD program provides benefits and 93% of science teachers strongly agree and 7% of science teachers agree that when they join the program they get new information. This new thing is related to the use of technology in learning practices and science materials that can be linked to local cultural activities.

Figure 3. Implementation of classroom instruction

It was revealed that teachers' TPACK knowledge increased after participating in the PD program and this knowledge was incorporated by teachers into their teaching practices in the classroom (Kelani & Khourey-Bowers, 2012). The new knowledge that teachers gain when participating in the PD program is implemented in their teaching practices in the classroom.

The improvement of teachers from the results of the TPACK test and designing lesson plans has an impact on good teaching practices. PD that connects the TPACK domain with the real-life learning experiences of teachers as instructional designers and conducting teaching greatly helps teachers deepen their understanding of student-centered technology applications and practice TPACK (Lee & Kim, 2017). A teacher who has good TPACK will be able to implement it in designing lesson plans and conducting instructions in the classroom. The new knowledge or information related to TPACK gained by teachers will affect their teaching practice although the way teachers use their knowledge will vary (Mouza, 2011). However, the analysis results of this relationship are not significant for Science Teachers G2 (69%) and G10 (80%). Even though they show good scores in designing lesson plans and learning practices, the TPACK test results still show a low percentage of scores. Even though teachers show the same ability in terms of designing and carrying out teaching practices in the classroom, their knowledge of TPACK can be different. Teachers use technology in teaching practice only to fit the context of the given TPD program, i.e. using technology and ethnoscience approach. All science teachers who have participated in the PD program carry out all stages well, design and implement good teaching practices as a result of the PD program. However, they will have different knowledge regarding the integration of technology in classroom instruction (Guzey & Roehrig, 2009).

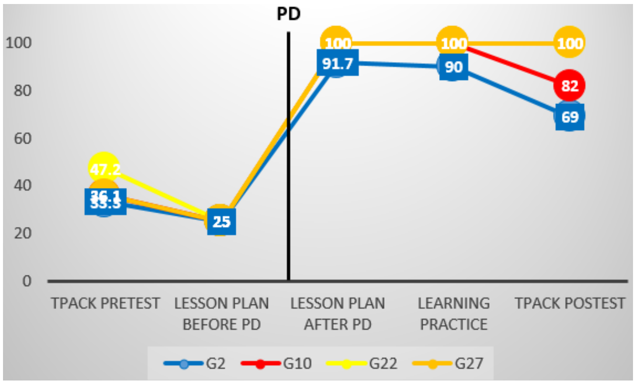

Figure 4. Percentage of TPACK test results, lesson plans design and science teachers' classroom practices

Conclusion

Teachers' TPACK is not only limited to understanding certain approaches to teaching, the instructional process, or even the integration of technology. It is important for a flexible and inclusive PD program based on TPACK to accommodate various philosophies, teaching styles, and teaching approaches so as to encourage teachers to choose based on suitability with reference to students' learning needs and preferences, and to be familiar with the combination of TPACK in every process of planning lesson and implementing it in the classroom.

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