Professional Competence of Prospective Elementary School Teachers in Designing Lesson Plans Integrating Project-Based Learning Models and TPACK

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Abstract: During the industrial revolution, the quality of education improved, and this was reflected in competent and professional teachers. Teacher professional competence can be achieved by combining personal, scientific, technological, social, and spiritual skills.. This study aims at assessing prospective teachers' professional abilities in developing lesson plans that are integrated with the Project Based Learning and TPACK models in Microteaching course. This study employs a qualitative approach with a case study research design by involving 10 prospective elementary school teachers enrolled in sixth semester. Data collection was carried out through interviews, observation, and documentation, while data analysis was carried out qualitatively, comprising data reduction, verification, and conclusions. The findings obtained revealed that the professional competence of prospective elementary school teachers was adequate but could be improved. According to the interviews, they were able to develop a scientific mindset in preparing lesson plans with subject mastery based on basic competencies and learning objectives. In fact, four participants were able to develop lesson plans using project-based learning models. In the analysis process, it was also found that these prospective elementary school teachers were able to integrate TPACK, meaning they knew how to link material with the use of technology and were able to teach it in simulation activities carried out in class. However, some of them still struggled to make project-based learning plans, especially in designing projects relevant to teaching materials. Overall, it can be concluded that the professional competence of prospective teacher students was adequate but could be improved, particularly in their capacity to design projects relevant to the material and learning objectives in elementary schools.

Keywords: Lesson Plan, Professional Competence, Prospective Teachers, Project-Based Learning Model, TPACK.

1. Introduction

The development of technology and information is currently growing rapidly from 4.0 (industrial revolution) to 5.0 (society). The use of technology is currently a major requirement not only in the industrial sector, but also in the world of education. Education is a benchmark in social status due to the power of education to influence, change, and even develop one's views, attitudes, and life skills. Education can also determine the progress of a country, as it is a conscious and planned effort to actively develop one's potential to have spiritual strength, religion, self-control, habits, intelligence and skills required for oneself, society, nation and state. Improvement in the quality of education is reflected in the presence of qualified teachers, therefore, the existence of quality, professional and prosperous teachers is a non-negotiable condition (Liesa-Orús et al., 2020).

Teaching and learning process is the core of the educational process, involving a series of activities by teachers and students to achieve the goals that have been set. Through learning activities it is hoped that there will be changes in new behavior as a result of their own experiences in interactions with their environment. The success of teaching and learning activities is not only determined by the school and curriculum, but is also largely determined by the competence of the teachers who teach them and guide them (Juuti et al., 2021). The teachers play significant roles in learning activities, thus they need to improve their role and competence because the teaching and learning process along with the learning outcomes are largely determined by their role and competence.

1.1. Problem Statement

Teacher competence refers to the teacher's and authority in carrying out their teaching profession. It is a qualitative description of the meaningful nature of teacher behavior. Teacher competence is also a combination of personal, scientific, technological, social, and spiritual abilities that form the standard competence of the teaching profession, including material mastery, student comprehension, educational learning, personal and professional development. Competent teachers will be better equipped in creating an effective, enjoyable learning environment, and managing their classes so that students learn at an optimal level.

According to the Regulation of the Minister of National Education of the Republic of Indonesia No. 16 of 2007, there are four general competency standards that teachers must possess, namely professional competence, pedagogic competence, personal competence, and social competence. Professional competence is defined as the ability to master the learning material extensively and in depth, which includes mastery of the substance of the content of the school curriculum material and the substance that covers the curriculum material, as well as providing scientific insight as a teacher (Miller et al., 2021; Paristiowati et al., 2022). Therefore, teacher competence is one of the factors that influence the achievement of learning and educational goals in schools because good teacher competence results in smart and responsible actions as learning agents carrying out tasks through the integration of knowledge, skills and attitudes.

One of the things that a teacher must prepare before starting the learning process is a lesson plan. According to the Regulation of Minister of Education and Culture No. 22 of 2016 and No. 65 of 2013 concerning Process Standards for Elementary and Secondary Education, Lesson Plans comprise learning activity plans developed for each face-to-face meeting for one or more meetings. Lesson Plans are subject learning designs developed by teachers at the beginning of each semester for classroom learning use. In preparing lesson plans, the teachers are certainly required to understand the competencies expected in the curriculum, pay attention to the individual differences among students, implement student-centered learning to encourage students' enthusiasm for learning, motivation, interest, creativity, initiative, inspiration, innovation and independence, prioritizing values and norms based on multiliteracy, integrating media, learning resources, and information technology relevant to teaching materials. Finally, positive feedback, reinforcement, enrichment, and remedy are provided, all of which are incorporated in an integrated, systematic, and effective manner based on the situation and conditions (Chatmaneerungcharoen, 2019; Saddhono et al., 2020).

In the implementation of the 2013 Curriculum, revisions were made to the basic competencies, it was a development of the previously used curriculum. The successful implementation of the 2013 curriculum cannot be separated from the teacher's role as the spearhead of education, one of the models developed in the 2013 curriculum is project-based learning, which integrates technology into the learning process. However, attention must be paid to teachers' readiness to tackle the challenges of this

new curriculum; there is a need to improve the quality of education by enhancing the teacher's competency, particularly teachers and prospective teachers at the school level. The demands of the 2013 curriculum are relevant to the changes to the independent curriculum launched by the Minister of Education and Culture, that is the concept of *Merdeka Belajar* (Freedom to Learn). This concept aims to improve the quality of education by including an element of flexibility towards freedom and self-disclosure as an educational institution that contributes to educating generations who are the nation's successors in the era of the industrial revolution 4.0 and society 5.0 (Suyanto, 2017).

Kurikulum Merdeka (Independent Curriculum), also known as the prototype curriculum, is a curriculum with various intra-curricular learning where the content is optimized, giving students enough time to explore concepts and build competence. Curriculum innovation in learning is intended spark ideas or certain actions to solve educational problems. Education units can also reduce the number of Basic Competency for each subject so that teachers and students can focus more on essential competencies for continuing learning at the next level. The prototype curriculum is a competency-based curriculum to support learning recovery by implementing project-based learning to support character development according to the Pancasila Student Profile (Maryati, et al., 2022).

Based on the results of initial observations, which included interviews and examination on lesson plan designed by the teacher at the Lhokseumawe City, it was found that while the ability to design lesson plans was good, however, the integration of learning models did not meet the expectations of the present curriculum, which focuses on projects and problem solving. Of the total 18 teachers interviewed, only three teachers had started to integrate PjBL-based lesson plans into the learning process in class. This was relevant to the initial data obtained from prospective elementary school teachers at universities in the city of Lhokseumawe who found it difficult to integrate the type of project to be done in the designed lesson plan. Furthermore, it was revealed that these prospective teachers found it challenging to select the appropriate media and information technology to incorporate into the lesson plan.

A number of previous studies discovered that that the competence of prospective teachers was more about the ability to compile learning tools in general and their basic teaching skills by utilizing technology (Aksela & Haatainen, 2019; Tican & Deniz, 2019). Therefore, researchers intend to conduct a study to assess prospective school teachers' professional competence in developing lesson plans integrated with project-based learning models in response to the current curriculum demands, as well as their ability to integrate technology relevant to teaching materials. This study can subsequently contribute to the knowledge of what aspects or skills that prospective elementary school teachers need to improve in order to teach 21st century skills to students through project-based learning models and TPACK.

With the demands of the current curriculum, it is necessary to improve the quality of teachers and prospective teachers. This can be accomplished by increasing the quality of pedagogic and professional competence. Thus, it is hoped that teachers and prospective teachers can implement project-based learning from lesson planning and its realization in class, so as to produce students who are able to develop high-level thinking skills and be creative in problem solving. The focus of this study is to analyze the responses of prospective teachers in designing lesson plans integrated with project-based learning models and TPACK in Microteaching course.

1.2. Related Research

Project-based learning is commonly thought of as a teaching method in which students respond to real-world questions or challenges through an extended process of inquiry.

Hossein et al., (2021) suggest that by applying the project-based learning model, students accompanied by teachers can create the final product (Producer Project), meaningful subject and enjoy knowledge or experience (Consumer Project), improve certain techniques or skills in solving intellectual problems particularly those related to projects, strengthening skills, multidisciplinary, and also being able to integrate values such as cooperation, organization, and time management in a practical way. Through project-based learning model, students can be involved in real situations, enabling them to explore and apply subject matter to complex problems and relevant to professional practice (Chiang & Lee, 2016). This is in line with several study findings which state that the existence of good professional competence when educators apply the PjBL model has a positive impact on student development, but in practice time allocation becomes a problem and is deemed insufficient to fully accomplish the learning objectives (Baysura, 2016; Chen & Yang, 2019).

Mastery and technological knowledge of prospective teachers can be measured by TPACK. TPACK instrument was prepared to assess the prospective teachers' technological knowledge, including related pedagogy and content. The process of developing this instrument includes dividing one of the domains of the TPACK framework into online TPK and offline TPK, resulting in seven dimensions in TPACK framework, namely Technological Knowledge (TK), Pedagogical Knowledge (PK), Content Knowledge (CK), Technological Content Knowledge (TCK), Pedagogical Content Knowledge (PCK), Technological Pedagogical Knowledge (TPK), and Technological Pedagogical Content Knowledge (TPACK)(Schmid, et al. 2021). TPACK refers to the knowledge constructs that teachers rely on to facilitate their teaching with technology to make the learning process more innovative. Koehler (2013) states that TPACK is a design that integrates technology in the learning process which includes pedagogy and content. By understanding and integrating TPACK in learning, an educator has been able to improve his competency in teaching skills in the 21st century, one of which is being able to develop critical, creative thinking skills and being able to utilize appropriate technology in learning, especially at the primary and secondary education levels (Syafie, 2019).

TPACK has been integrated into the learning process in various studies, with a focus on the teacher's ability to select the appropriate material and technology. Furthermore, the results of the analysis of the teachers' ability of integrating TPACK are excellent, particularly in aspects of Kindergarten, TCK, and TPK (Fajero et al., 2021; Santos & Castro, 2021). Additionally, Joldanova et al., (2022) stated that incorporating TPACK into learning increases students' motivation and self-efficacy because the presence of technology facilitates access for students to obtain teaching material based on the needs of the subject matter, as well as having an impact on the development of confidence, social skills, and communication.

Furthermore, the realization can be observed in several countries where teachers say they lack adequate knowledge about Project Based Learning (PjBL), making it difficult for them to guide students in this process, aside from the availability of technology-based infrastructure and the teachers' ability to use it. In a study of prospective teachers and pre-service teachers, PjBL was found to improve a teacher's professional competence as an educator, it also motivated them to study effectively and perfected their studies, management, and social skills (Mansur, 2019; Tsybulsky & Muchnik-Rozanov , 2019).

1.3. Research Objectives

In the literature review, no studies were found related to the professional competence of prospective elementary school teachers in preparing integrated lesson plans with project-based learning models and technology. Thus, this study aims to acknowledge the understanding of prospective elementary school teachers in relation to their

professional competence and their ability in integrating project-based learning models in lesson plans to be relevant to material taught in elementary schools.

2.   Theoretical Framework

In facing the industrial revolution 4.0 towards society 5.0, teachers are required to improve their own competence, one of which is through professional competence development, particularly in designing lesson plans by selecting the appropriate learning model and integrating technology. Professional competence refers to the teacher's ability to master the learning material extensively and in depth in order to provide students with progress in learning. To become a professional teacher, teachers must be able to master the material, including academic abilities that benefit students; in other words, the teacher plays a role in transforming educational input to produce good output (Alhajri, 2021; Purwaningsih et al., 2020). One of the learning models recommended in the current independent curriculum, particularly at the elementary school level, is the project-based learning model. Project-based learning is a curricular approach that is used across disciplines that has been used globally at all levels of education in both private and public schools. Four features common to all PjBL models are driving questions, extended learning, collaboration, and community connections (Duke et al., 2021; Kokotsaki, 2016). According to Prince and Felder(Prince & Felder, 2006), Project Based Learning Model is a learning model that creates conditions for students to learn independently in order to recognize their learning needs, identify goals, search for resources, answer their questions, and share knowledge with others. In other words, Project-based learning begins with assignments that lead to the final product in the form of written or oral reports that will be communicated (Bagheri et al., 2020; Indrawan, 2018). As for technology mastery, teachers are expected to improve their competence through mastering the TPACK approach used by Shulman (Shulman, 1986), namely Pedagogical Content Knowledge (PCK), which explains how and why teachers' pedagogical knowledge and content cannot be separated. Teachers need to master the interaction between technology, pedagogy, and content in order to implement these strategies and assist students understand the material (Koehler, 2013; Schmidt et al., 2010; Srisawasdi, 2012).

3.   Methods

3.1 Research Design

The qualitative research method was employed as it is aimed to provide meaning or interpretation of a phenomenon or symptom, either to the actor or the product of his actions naturally (Creswell, 1998). This study was a descriptive study that sought to describe a phenomenon or case that can be a program, event, institutional process, or social group by describing variables related to the problem and unit under study in natural conditions. As for the research design, a descriptive case study was employed as it entailed an intensive and in-depth investigation of events and activities. With case study, an in-depth and detailed description of a situation or object can be discovered. This study analyzed and described the professional competence of prospective elementary school teachers in designing lesson plans integrated with the project-based learning model and Technological Pedagogical Content Knowledge (TPACK).

1.2. Participants

The participants of this study were selected using purposive sampling. Purposive sampling is a non-random sampling technique in which the research sample is expected to respond to the research context, determined by specific identities that match the research objectives (CE et al., 2003). The participants of this study involved 10 prospective elementary school teachers enrolled in sixth semester who took Microteaching course in the even semester of 2021/2022 at a university in the city of

Lhokseumawe. The selection of prospective elementary school teachers as participants in this study was based on their ability to select a project-based learning model, design projects that are relevant to teaching materials, and integrate technology in the learning process. Learning courses in the previous semester revealed the abilities of these prospective elementary school teachers. Since the samples were individuals who were directly involved in the process of designing, implementing, and evaluating peer teaching activities, quality data were expected.

1.3. Data Collection

The data were collected by using interviews, observation, and documentation, in addition to recorders and notes were the tools used to record the data in the field. A guided interview was conducted. According to Alsaawi (2014), a guided interview is conducted by subjects of evaluation by asking prearranged questions. The indicators of the study variables to be tested are the professional competence of teachers adopted from (Suhana & Hanafiah, 2014), as presented in Table 1.

Table 1. Indicators of Professional Competence

Variable	Aspect	Indicator	Number of Question Items
Professional Competence	Mastering the material, structures, concepts, and scientific mindsets that support the subjects being taught	1. Able to develop a mindset in preparing learning devices	1
		2. Able to explain subject matter to students systematically without looking at textbooks/handbooks	1
		3. Able to express ideas when developing learning tools that match the demands of the curriculum.	2
	Mastering Competency Standards and Basic Competency in the subject/field of development being taught	1. Mastering the core competencies and basic competencies that will be taught	1
		2. Able to understand the material, taught well to students.	1
	Developing subject matter taught creatively	1. Able to develop teaching materials in accordance with the latest scientific developments.	1
		2. Undertake self-development that supports mastery of teaching materials.	1
		3. Able to provide students with an understanding of concepts related to teaching materials	1

	that will be taught to students	
	4. Able to integrate learning models that are relevant to current curriculum demands	2
Developing professionalism in a sustainable manner by taking reflective action	1. Able to develop themselves through seminars, training and workshops	1
	2. Able to reflect on performance on an ongoing basis to improve professionalism as a teacher	2
Utilizing information and communication technology to communicate and develop him/herself	1. Able to master the latest information and communication technology.	2
	2. Able to access the internet to find new sources of knowledge in his/her profession.	1
Total		17

3.4. Data Analysis

The stages of data analysis were carried out qualitatively, comprising reducing the data, verifying, and concluding. All data obtained in this study, including observations, interviews, and documentation reviews, were examined qualitatively. The acquired data were a description of opinions, knowledge, experiences, and other aspects to be analyzed and presented and presented in order to be meaningful.

4. Finding

This study is a descriptive qualitative research conducted on prospective elementary school teachers, namely sixth semester students in Microteaching course. This study aims to analyze the ability of prospective teachers in designing lesson plans integrated with project-based learning and technology learning models. In this study, data were collected by conducting interviews, observations, and documentation. The research process entailed interviews, observations, and documentation of the professional competence of 10 students in designing lesson plans integrated with project-based learning and technology. The indicators of professional competence were used as guidelines in this study, comprising: 1) The ability to master material, concepts, and scientific thinking patterns that support learning, 2) Mastering the competency standards and basic competencies in the subjects being taught, 3) Developing subject matter creatively, 4) Developing professionalism in a sustainable manner, and 5) Utilizing information and communication technology and developing it by themselves.

Following an in-depth analysis, five themes were obtained in this study, namely: 1) Prospective teachers' understanding of professional competence, 2) Prospective teachers' understanding of the components of the project-based learning model and TPACK, 3) The ability of prospective teachers to integrate the components of project-based learning model, 4) The ability of prospective teachers to integrate technology

(TPACK) relevant to teaching materials, and 5) Prospective teachers' overall professional ability in preparing lesson plans based on project-based learning and TPACK models.

Prospective Teachers' Understanding of Professional competence

According to the findings of the interview, students understood teachers' professional competence in terms of their ability to prepare lesson plans that were relevant to the curriculum and their ability to use technology. As stated by DS, SP and M, "in my opinion, professional competence is a teacher's ability to prepare lesson plans in class. In addition to teaching material, the teacher must also be able to use technology". SN further stated "Beside the ability to prepare lesson plans, teachers must also be productive by upgrading themselves in order to know developments in education, especially in elementary schools."

Prospective Teachers' Understanding of Project-Based Learning Model and TPACK

In interviews concerning prospective teachers' understanding of the project-based learning model and TPACK, it was found that the majority of participants understood the model as a learning process that required experiments and TPACK was understood as requiring technology in the learning process. Prospective teachers who understood the project-based learning model and TPACK well were SN, DS, and M, as proven by their statement, "The project-based learning model that I understand is a model that is able to develop students' scientific thinking skills through a project, so the teacher must be able to design the project well and according to the material, while TPACK is an approach that can be used in the learning process, in other words, it is more about the teacher's ability to incorporate appropriate technological elements that is relevant to the material to be taught."

The Ability to Integrate Project-Based Learning Model

Based on the findings of interviews, observations, and documentation, four students were able to prepare lesson plans that are integrated with the project-based learning model well. According to the findings of observations on ten participants, it was found that in terms of mastery of materials, structures, scientific concepts, and mindsets that support the course, the participants were able to develop their mindset in preparing lesson plans including in aspects of mastery of competency standards and basic competencies. In selecting a learning model, it was also seen that prospective teachers were able to opt for a learning model that was relevant to the teaching material. However, six out of ten participants struggled in developing their ideas into learning tools that corresponded to the demands of the current curriculum, namely project-based learning plans. It was evident from the prepared project design that did not adhere to the syntax of project-based learning. Furthermore, the observation results revealed that participants had difficulties explaining the material systematically without checking the textbook. In terms of creatively developing the teaching material, it was discovered that the majority of participants claimed that they had attempted to design teaching materials that were relevant to the latest scientific development. Meanwhile, four other participants were able to design projects for lesson plans in science, social studies, and civics.

The Ability to Integrate Technology Relevant to Teaching Materials in Learning Plans

In terms of technology integration, four participants attempted to integrate technology in the display of teaching materials and in the evaluation process, such as by using Canva, Liveworksheet and Quizziz. This issue was also evident in the documentation of collected lesson plans and the teaching simulation of prospective elementary school teachers in front of the class. As stated by some prospective elementary school teachers, namely M, SP, DM: "in the lesson plan that I have compiled, in addition to

trying to incorporate a project-based model, there are also several applications that I will use, like PowerPoint that I made using Canva. There are also learning videos, and for student worksheet I try to use Liveworksheets even though the appearance is not so good, and Quizziz which is easy to use to assess the students through multiple choice questions." From this statement, it was proven that the prospective teachers had attempted to integrate technology in learning and adjusted the teaching material.

Professional competence of Prospective Teachers in Designing Lesson Plans Integrating Project-Based Learning and TPACK Models

In general, according to the findings of interviews and observations of prospective teachers' professional competence in designing lesson plans integrating project-based learning and TPACK models, only four out of ten were deemed capable of fully developing their potential. In addition to the ability to prepare project-based learning plans and technology integration, findings of the interviews revealed that prospective elementary school teachers continued to build their potential as prospective teachers by attending seminars. According to interviews with SP, DM, M, they stated that "nowadays, technological advances are growing, besides that the curriculum has also changed a lot so I have to learn again so that I understand better and I can implement it when I become a teacher. My efforts include participating in seminars on creating creative learning media, on the use of technology, like *Kahoot* and *Quizziz*." This statement was relevant to observation and documentation, as the prepared lesson plan was based on a project-based model and utilized various information technologies to prepare materials and learning media that corresponded to the teaching material. In peer teaching activities, prospective elementary school teachers employed various information technology-based media such as PowerPoint, YouTube videos, and applications for evaluation such as Quizziz that supported the material.

5. Discussion

This study resulted in five themes that were identified based on the objectives of this study. The findings of interviews, observations, and documentation related to the professional competence of prospective elementary school teachers revealed that the majority of students were capable of preparing learning tools, namely lesson plans well, but there were various obstacles in the process. Students were able to identify core competencies and basic competencies relevant to the material and learning steps in the lesson plan, however they were constrained in selecting the appropriate learning model that was in accordance with the material to be taught. Several studies suggest that not all teacher's planning for learning can run smoothly, there are factors that might either hinder or support teachers in preparing the appropriate learning process (H Alanazi, 2019).

In terms of preparing material and learning resources, the participants understood the material to be taught and added sources and media to be taught in peer teaching. To make the learning process engaging, the professional competence of teachers and prospective teachers came into play, especially in selecting learning appropriate and relevant resources. In terms of selecting materials and learning resources, the capacity of prospective teachers was very good, as reflected by their ability to select materials that were in accordance with learning objectives while accommodating the students' characteristics. It is critical to develop teachers' professional competencies in order to improve student quality. Teachers and prospective teachers can contribute to this improvement by fulfilling their academic qualifications and competencies based on advances in science, technology and art (Zhorova, 2022).

When preparing learning, teachers should be able to select and integrate appropriate learning models. From the results of interviews and observations according to the indicators in Table 1, it can be inferred that the prospective teachers' professional

competence in preparing lesson plans integrated with Project-Based Learning models and technology through Microteaching course still need to be developed. Assistance and reinforcement are required, particularly in the aspect of determining learning models that are relevant to learning materials and selecting the appropriate technology as a learning resource. Improving teacher competency is imperative, particularly in preparing lesson plans, which covers the ability to select and apply learning models that can help students develop their critical thinking skills. To prepare professional prospective teachers, a problem-based or project-based learning model can be utilized so that they are accustomed to addressing various challenges linked to preparing lesson plans (Maritasari, 2021). Furthermore, according to a study by (Juuti et al., 2021) regarding teachers' professional competence, providing training to teachers and getting them used to implementing project-based learning would boost their professional competence in preparing creative learning.

Based on the aforementioned description, the findings of this study are expected to contribute to helping elementary school teachers and prospective teachers improve their professional competence. Various efforts can be done to promote teacher professionalism in higher institutions, including improving the quality of the learning process. Prospective teachers and teachers are also expected to be able to improve their own quality by keeping up with modern educational trends in which the learning process is technology-based, staying up to date with curriculum changes, and continuing to actively participate in various training or self-development workshops. Naturally, growth in teacher professionalism must coexist with the curriculum transition from the 2013 curriculum to an independent curriculum or template in order for the anticipated goals to be achieved, so that the expected goals can be realized properly by being able to produce quality human resources and also improve the quality of Indonesian education.

6.   Conclusion

A teacher is a key component in the teaching and learning process in schools because he/she directly contributes to the intellectual and spiritual development of superior and intelligent human resources. Improving teachers' and prospective teachers' professional competence is imperative as an attempt to improve the quality of education, particularly in Indonesia. Based on the findings of this study, not all prospective teachers understood the significance of professional competence and its supporting indicators. It was evident that students were still using non-project-based learning models when selecting and implementing models. This can also be seen from the results in form of the designed lesson plan. There were four prospective elementary school teachers who integrated the project-based learning model and TPACK using technology.

Limitation

The limitations of this study lie in the research process. One of the factors that became an obstacle was the readiness of the interviewed students in relation to the number of students and the level of student ability in preparing learning tools.

Recommendation

The findings indicated that while prospective elementary school teachers had a good understanding of professional competence, their ability to design lesson plans for projects and TPACK was still lacking. This was evident from the designed lesson plans and the degree to which TPACK included technology. In order for future elementary school teachers to prepare projects that are relevant to the learning objectives and are able to incorporate elements of technology, it is necessary to provide reinforcement and assistance in designing lesson plans that are integrated with the Project Based Learning model and the TPACK approach.

Conflict of Interest

The Authors declare that there is no conflict of interest.

Acknowledgments

References

Aksela, M., & Haatainen, O. (2019). Project-Based Learning (PBL) in Practise: Active Teachers' Views of Its' Advantages And Challenges. *Integrated Education for the Real World : 5th International STEM in Education Conference Post-Conference Proceedings*, Queensland University of Technology, 9–16. https://researchportal.helsinki.fi/en/publications/project-based-learning-pbl-in-practise-active-teachers-views-of-i

Alhajri, A. (2021). Effect of Students ' Attractiveness and Tidiness on the Development of Student-Teachers ' Expectations of Their Intellectuality Abdullah Alhajri. *Journal of Educational and Social Research*, *11*(4), 26–39. https://doi.org/https://doi.org/10.36941/jesr-2021-0074

Alsaawi, A. (2014). A Critical Review of Qualitative Interviews in Applied Linguistics. *Applied Linguistics*, *32*(1), 6–24. https://doi.org/10.1093/applin/amq043

Bagheri, M., Ali, W. Z. W., Abdullah, M. C. B., & Daud, S. M. (2020). Effects of Project-based Learning Strategy on Self-directed Learning Skills of Educational Technology Students. *Contemporary Educational Technology*, *4*(1). https://doi.org/10.30935/cedtech/6089

Baysura, O. D. et al. (2016). Perceptions of Teacher Candidates Regarding Project-Based Learning. *Eurasian Journal of Educational Research*, *16*(62), 15–36. https://doi.org/10.14689/ejer.2016.62.3

CE, S., Swensson, B., & Wretman, J. (2003). *Model assisted survey sampling. Springer*. Springer.

Chatmaneerungcharoen, S. (2019). Improving Thai Science Teachers' TPACK through an Innovative Continuing Professional Development Program. *Journal of Physics: Conference Series*, *1340*(1). https://doi.org/10.1088/1742-6596/1340/1/012017

Chen, C. H., & Yang, Y. C. (2019). Revisiting the effects of project-based learning on students' academic achievement: A meta-analysis investigating moderators. *Educational Research Review*, *26*, 71–81. https://doi.org/10.1016/j.edurev.2018.11.001

Chiang, C. L., & Lee, H. (2016). The Effect of Project-Based Learning on Learning Motivation and Problem-Solving Ability of Vocational High School Students. *International Journal of Information and Education Technology*, *6*(9), 709–712. https://doi.org/10.7763/ijiet.2016.v6.779

Creswell, J. W. (1998). *Qualitative Inquiry And Research Design: Choosing Among Five Traditions*. SAGE Publications.

Duke, N. K., Halvorsen, A. L., Strachan, S. L., Kim, J., & Konstantopoulos, S. (2021). Putting PjBL to the Test: The Impact of Project-Based Learning on Second Graders' Social Studies and Literacy Learning and Motivation in Low-SES School Settings. In *American Educational Research Journal* (Vol. 58, Issue 1, pp. 160–200). https://doi.org/10.3102/0002831220929638

Fajero, T., Festiawan, R., Anggraeni, D., & ... (2021). Analisis Technological Pedagogical Content Knowledge (TPACK) dalam Implementasi Metode Pembelajaran Daring pada Era Covid-19 di SMA Negeri se-Kota …. *Jurnal Pendidikan …, 7*(2), 342–353. https://ojs.mahadewa.ac.id/index.php/jpkr/article/view/1136

H Alanazi, M. (2019). A Study of the Pre-Service Trainee Teachers Problems in Designing Lesson Plans. *Arab World English Journal, 10*(1), 166–182. https://doi.org/10.24093/awej/vol10no1.15

Hossein-Mohand, H., Trujillo-Torres, J. M., Gómez-García, M., Hossein-Mohand, H., & Campos-Soto, A. (2021). Analysis of The Use and Integration of The Flipped Learning Model, Project-Based Learning, and Gamification Methodologies by Secondary School Mathematics Teachers. *Sustainability (Switzerland), 13*(5), 1–18. https://doi.org/10.3390/su13052606

Indrawan, E. et al. (2018). Review Project Based Learning. *International Journal of Science and Research, 8*(4), 1014–1018. www.ijsr.net

Joldanova, D., Tleuzhanova, G., Kitibayeva, A., Smanova, G., & Mirza, N. (2022). Formation of TPACK and Acmeological Competency of Future Teachers in Foreign Language Education. *International Journal of Education in Mathematics, Science and Technology, 10*(4), 935–954. https://doi.org/10.46328/ijemst.2717

Juuti, K., Lavonen, J., Salonen, V., Salmela-Aro, K., Schneider, B., & Krajcik, J. (2021). A Teacher–Researcher Partnership for Professional Learning: Co-Designing Project-Based Learning Units to Increase Student Engagement in Science Classes. *Journal of Science Teacher Education, 32*(6), 625–641. https://doi.org/10.1080/1046560X.2021.1872207

Koehler, M. J. et al. (2013). What is Technological Pedagogical Content Knowledge (TPACK)? *Journal of Education, 193*(3), 13–19. https://doi.org/10.1177/002205741319300303

Kokotsaki, D. et al. (2016). Project-Based Learning: A Review of The Literature. *Critical Studies on Security, 2*(2), 210–222. https://doi.org/https://doi.org/10.1177/1365480216659733

Liesa-Orús, M., Latorre-Cosculluela, C., Vázquez-Toledo, S., & Sierra-Sánchez, V. (2020). The technological challenge facing higher education professors: Perceptions of ICT tools for developing 21st Century skills. *Sustainability (Switzerland), 12*(13). https://doi.org/10.3390/su12135339

Mansur, U. A. et al. (2019). Trello as Virtual Learning Environment and Active Learning Organiser for PBL Classes: An analysis under Bloom's Taxonomy. *International Symposium on Project Approaches in Engineering Education, 9*, 245–252. https://repositorium.sdum.uminho.pt/bitstream/1822/66659/1/2019_Uebe_et_al_PAEE_ALE_PROCEEDINGS-páginas-269-276.pdf

Maritasari, D. B. S. K. P. (2021). The Effect of Project Based Learning Assisted by Mobile Learning Applications and Learning Motivation on the Competence and Performance of Teachers. *Turkish Journal of Computer and Mathematics …, 12*(6), 3488–3498. https://www.turcomat.org/index.php/turkbilmat/article/view/7137%0Ahttps://www.turcomat.org/index.php/turkbilmat/article/download/7137/5811

Maryati, S., & et al. (2022). The Effectiveness of Mentoring in the Implementation of the Project-based Learning (PjBL) Model in the Independent Curriculum for PAUD Educators. *European Journal of Education and Pedagogy, 3*(6), 12–18. https://doi.org/10.24018/ejedu.2022.3.6.471

Miller, E. C., Severance, S., & et al. (2021). Motivating Teaching, Sustaining Change in Practice: Design Principles for Teacher Learning in Project-Based Learning Contexts. *Journal of Science Teacher Education*, *32*(7), 757–779. https://doi.org/10.1080/1046560X.2020.1864099

Paristiowati, M., Rahmawati, Y., Fitriani, E., Satrio, J. A., & Hasibuan, N. A. P. (2022). Developing Preservice Chemistry Teachers' Engagement with Sustainability Education through an Online, Project-Based Learning Summer Course Program. *Sustainability (Switzerland)*, *14*(3). https://doi.org/10.3390/su14031783

Prince, M. J., & Felder, R. M. (2006). Inductive teaching and learning methods: Definitions, comparisons, and research bases. *Journal of Engineering Education*, *95*(2), 123–138. https://doi.org/10.1002/j.2168-9830.2006.tb00884.x

Purwaningsih, E., Sari, A. M., Yuliati, L., Masjkur, K., Kurniawan, B. R., & Zahiri, M. A. (2020). Improving the problem-solving skills through the development of teaching materials with STEM-PjBL (science, technology, engineering, and mathematics-project based learning) model integrated with TPACK (technological pedagogical content knowledge). *Journal of Physics: Conference Series*, *1481*(1). https://doi.org/10.1088/1742-6596/1481/1/012133

Saddhono, K., Sueca, I. N., Sentana, G. D. D., Santosa, W. H., & Rachman, R. S. (2020). The application of STEAM (Science, Technology, Engineering, Arts, and Mathematics)-based Learning in Elementary School Surakarta District. *Journal of Physics: Conference Series*, *1573*(1). https://doi.org/10.1088/1742-6596/1573/1/012003

Santos, J. M., & Castro, R. D. R. (2021). Technological Pedagogical content knowledge (TPACK) in action: Application of learning in the classroom by pre-service teachers (PST). *Social Sciences & Humanities Open*, *3*(1), 100110. https://doi.org/10.1016/j.ssaho.2021.100110

Schmid, M., & et al. (2021). Self-reported technological pedagogical content knowledge (TPACK) of pre-service teachers in relation to digital technology use in lesson plans. *Computers in Human Behavior*, *115*(September 2020), 106586. https://doi.org/https://doi.org/10.1016/j.chb.2020.106586

Schmidt, D. A., Thompson, A. D., Koehler, M. J., & Shin, T. S. (2010). *Technological Pedagogical Content Knowledge (TPACK): The Development and Validation of an Assessment Instrument for Preservice Teachers*. *42*(2), 123–149.

Shulman, L. S. (1986). Those Who Understand: Knowledge Growth in Teaching. *American Educational Research Association Is Collaborating with JSTOR to Digitize, Preserve and Extend Access to Educational Researcher.*, *15*(2), 1–14. https://definicion.de/computo/

Srisawasdi, N. (2012). The Role of TPACK in Physics Classroom: Case Studies of Preservice Physics Teachers. *Procedia - Social and Behavioral Sciences*, *46*, 3235–3243. https://doi.org/10.1016/j.sbspro.2012.06.043

Suhana, C., & Hanafiah, N. (2014). *Konsep Strategi Pembelajaran*. Refika Aditama.

Suyanto, S. (2017). A reflection on the implementation of a new curriculum in Indonesia: A crucial problem on school readiness. *AIP Conference Proceedings*, *1868*(August). https://doi.org/10.1063/1.4995218

Syafie, H. et al. (2019). Technological Pedagogical Content Knowledge (TPACK) in Teaching 21st Century Skills in the 21st Century Classroom. *Asian Journal of University Education*, *15*(3), 24–33. https://eric.ed.gov/?id=EJ1238639

Tican, C., & Deniz, S. (2019). Pre-service teachers' opinions about the use of 21st century

learner and 21st century teacher skills. *European Journal of Educational Research*, *8*(1), 181–197. https://doi.org/10.12973/eu-jer.8.1.181

Tsybulsky, D. et al. (2019). The development of Student-Teachers' Professional Identity While Team-Teaching Science Classes Using a Project-Based Learning Approach: A multi-Level Analysis. *Teaching and Teacher Education*, *79*(2), 48–59. https://doi.org/10.1016/j.tate.2018.12.006

Zhorova, I. et al. (2022). Teachers' training for the use of digital tools of the formative assessment in the implementation of the concept of the New Ukrainian School. *Educational Technology Quarterly*, *2022*(1), 56–72. https://doi.org/10.55056/etq.11