International Journal of Teaching and Learning (INJOTEL) e-ISSN: 3025-8308
Vol. 3 No. 9, 2026, pages: 1~14

FOSTERING CREATIVE THINKING SKILLS IN PROSPECTIVE ELEMENTARY SCHOOL TEACHERS: DEVELOPING TEACHING MATERIALS BASED ON THE PROJECT-ORIENTED TPACK APPROACH

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Abstract

The results of the preliminary study show that the creative thinking skills of prospective elementary school teacher students are relatively low, especially in designing technology-based learning that is to the needs of the 21st century. Therefore, this study aims to develop project-oriented TPACK (Technological Pedagogical Content Knowledge)-based teaching materials to improve the creative thinking skills of elementary school teacher education students. This study used a research and development (R&D) method adapted from Borg & Gall. The subjects of the study consisted of 128 elementary school teacher education students involved in learning planning for elementary schools. The study results show that project-oriented TPACK-based teaching materials are valid, practical, and effective. Experts have confirmed that the teaching materials are valid in construction and content. In addition, observations of increasing student activity at each meeting indicate that the teaching materials are applied practically in learning planning. The students' creative thinking skills test results show that these teaching materials effectively improve the creative thinking skills of prospective teachers. This study implies that using the proper method can improve students' creative thinking skills to design various alternative solutions to problem-solving in learning. This study suggests further developing project-oriented TPACK-based teaching materials for elementary school students.

Keyword: Creative thinking skills; TPACK framework; Project-oriented learning

INTRODUCTION

Creative thinking skills are increasingly recognized as essential skills that students need, especially for those studying in the field of education (Thornhill-Miller et al., 2023). This skill is essential for students' personal development and crucial in the educational context to prepare them to face complex challenges in the world of education. Creative thinking skills enable individuals to generate innovative ideas, solve problems in new and efficient ways, and adapt to continuous change (Tang et al., 2020). In education, this skill is essential for designing engaging learning, overcoming various problems that arise in the learning process, and inspiring students to think outside the box and find creative solutions to issues faced (Sternberg, 2003). However, many students, including prospective teachers, need help developing this skill to its full potential.

Based on various studies and observations at several state universities in Indonesia, it was found that the creative thinking skills of prospective elementary school teachers still need

to improve. Observation results show that most prospective elementary school teacher students need help generating various alternative solutions when faced with creative problems. Students are often trapped in conventional thinking and need help identifying innovative solutions. In addition, their ability to design creative learning and utilize technology in the learning process still needs to be improved. This is undoubtedly a big problem because prospective teachers are expected not only to have strong theoretical knowledge but also to be able to design creative and innovative learning, which can encourage students to develop their critical and creative thinking skills (Wang, 2020).

The problem of low creative thinking skills among prospective teacher students impacts the quality of learning they plan and implement in the future and also affects how they teach and interact with students. In an increasingly complex world of education, teachers are needed who can transfer knowledge and inspire students to think creatively, solve problems, and innovate. Therefore, efforts to improve the creative thinking skills of prospective teacher students are significant.

Improving these creative thinking skills requires the right strategy. One approach that can be used is to choose a learning model and strategy to stimulate student creativity optimally. One model that can be applied is the TPACK (Technological Pedagogical Content Knowledge) model. The TPACK model, developed by Mishra and Koehler (2006), provides a comprehensive approach to integrating three important aspects of learning, namely technology, pedagogy, and content (Tseng et al., 2022; Tunjung, 2022; Ching & Roberts, 2020). TPACK helps teachers or prospective teachers develop in-depth knowledge of how technology can be used effectively in a pedagogical context to support learning certain materials (Tondeur et al., 2020; Santos & Castro, 2021; Zhang & Fang, 2022). In this case, the TPACK model can help students understand and utilize technology creatively in designing engaging and effective learning.

The project-based approach is one effective way to integrate the TPACK model into learning. PjBL encourages students to learn through real-world experiences by working on relevant projects requiring them to think creatively, collaborate, and solve problems innovatively (Barak & Yuan, 2021; Ekayana et al., 2024; Wilson, 2021). PjBL provides opportunities for students to apply the knowledge and skills they have learned in more practical and applicable contexts. Thus, PBL improves creative thinking skills and provides hands-on experiences that can help students integrate technology in more meaningful ways in the learning context (Bell, 2010). However, to ensure that the project-based TPACK model can be implemented effectively, teaching materials that support the implementation of this model must be developed. Appropriate teaching materials can be a very effective tool to facilitate students in designing and implementing project-based learning by optimally utilizing technology (Ngereja, Hussein, & Andersen, 2020; Saad & (Ngereja, Hussein, & Andersen, 2020; Saad & Zainudin, 2022).

TPACK-based teaching materials can provide clear guidance on integrating technology into learning, choosing the proper pedagogical methods, and designing creative and innovative learning (Mustadi et al, 2024). Project-oriented TPACK-based teaching materials can help prospective teachers better understand how to design practical and fun learning that motivates students to participate actively in the learning process.

One solution that can be applied is the development of project-oriented TPACK-based teaching materials to improve the creative thinking skills of prospective elementary school teachers. The development of these teaching materials is designed to support students in integrating technology, pedagogy, and content simultaneously in the context of project-based learning. By using these teaching materials, students are expected to be able to design and implement creative learning, which not only involves understanding the content but also the wise use of technology to create engaging and innovative learning. In addition, these teaching materials can also help students design learning that can stimulate their creativity and encourage them to think critically and creatively.

The development of project-oriented TPACK-based teaching materials also positively impacts the overall quality of education. By developing TPACK-based teaching materials, prospective teacher students learn to design technology-based learning and gain important skills in integrating various learning elements that can create an atmosphere that supports the development of students' creative thinking skills. As prospective educators, students are expected to have in-depth theoretical knowledge and practical skills in designing and implementing learning that can inspire and motivate students to think creatively.

In conclusion, creative thinking skills are an important competency that prospective elementary school teacher students must possess. However, based on observations, this skill still needs to improve among students. Therefore, an appropriate strategy is needed, one of which is to apply a project-based TPACK model. The development of project-oriented TPACK-based teaching materials can be an effective solution to improve the creative thinking skills of prospective teacher students, which will ultimately improve the quality of learning in elementary schools. Therefore, further research and development in this field are needed to prepare creative and innovative prospective teachers to face the world of education's future challenges.

METHOD

This study used the Research and Development (R&D) method which aims to develop teaching materials based on the project-oriented TPACK approach to improve the creative thinking skills of prospective elementary school teacher students. This R&D method adapts the development model from Borg & Gall (2007) which consists of ten steps. These stages are designed to ensure that the teaching materials developed are valid, practical, and effective in implementing learning. The research population included all students of the Elementary

School Teacher Education (PGSD) study program at three state universities in Indonesia. The research sample was determined using a purposive sampling technique, with the criteria of fifth-semester PGSD students who had completed basic pedagogical courses and had experience in preparing lesson plans. The number of samples consisted of 128 students. This research was conducted for eight months, from February to September 2024.

The research instruments used included a validation questionnaire to assess the construction, content, and language aspects of teaching materials by experts, an observation sheet to assess the activities of lecturers and students during learning, a creative thinking skills test designed based on indicators of fluency, flexibility, originality, and elaboration, and a questionnaire to measure students' perceptions of the ease of use and benefits of teaching materials.

The data collected were analyzed qualitatively and quantitatively. The validity of teaching materials was analyzed based on the average score of expert assessments, which was declared valid if the average score was ≥ 4 on a Likert scale. The practicality of teaching materials was analyzed through the percentage of achievement of observed lecturer and student activities, with practical criteria if the level of achievement was ≥ 80%. The effectiveness of teaching materials was measured through the increase in the gain score between the initial test (pretest) and the final test (posttest) of students' creative thinking skills. The perception questionnaire was analyzed based on the percentage of positive student responses, which was considered satisfactory if ≥ 85% of students gave positive responses. Through this methodology, it is expected that the teaching materials based on the project-oriented TPACK approach developed can facilitate optimal learning and contribute to improving the creative thinking skills of prospective elementary school teacher students.

RESULTS AND DISCUSSION

This study aims to develop project-oriented TPACK-based teaching materials and to assess the validity of the developed teaching materials. Validation of teaching materials was carried out by involving three validators, namely material experts, instructional design experts, and media and language experts. Validation was carried out on three main aspects, namely instructional design, materials, and media and language. The validation results showed that the developed teaching materials had a very good level of validity in all aspects tested.

1. Results of Validation of Project-Oriented TPACK-Based Teaching Materials Instructional Design Validation

Instructional design validation was conducted to assess the suitability of learning objectives with expected competencies, clarity of learning steps, the relationship between theory and practice, selection of appropriate learning methods, and the use of relevant

project approaches. Table 1 shows the results of instructional design validation by the three validators using a 1–5 assessment scale. Based on Aiken's V calculation, the validity value of the instructional design shows a figure of 0.73, which is included in the valid category.

Table 1: Results of Instructional Design Validation

No.	Assessed Aspects	Validator 1 (Score)	Validator 2 (Score)	Validator 3 (Score)	Average of Score	Aiken's V	Categories of Validation
1	Alignment of learning objectives with competencies	5	4	5	4.67	0.67	Valid
2	Clarity of learning steps	4	5	4	4.33	0.50	Valid
3	Relationship between theory and practice in the material	5	5	5	5	1.00	Highly Valid
4	Selection of appropriate learning methods	4	4	5	4.33	0.50	Valid
5	Use of relevant project approaches	5	5	5	5	1.00	Highly Valid
Total Score				**23.66**	**0.73**	**Valid**	

From the results of this validation, the instructional design of the teaching materials is very much based on the principles of effective learning. The clarity of the learning steps and the relationship between theory and practice are aspects that receive the primary attention of the validator. This shows that the teaching materials have the potential to facilitate students in developing creative thinking skills.

Material Validation

Material validation aims to assess the suitability of the material to the curriculum, the quality and depth of the material, the relevance of the material to the TPACK approach, the completeness and diversity of project examples, and the clarity and readability of the material. Table 2 shows the results of the material validation, which obtained an Aiken's V value of 0.67, which is in the valid category.

Table 2: Results of Material Validation

No.	Assessed Aspects	Validator 1 (Score)	Validator 2 (Score)	Validator 3 (Score)	Average of Score	Aiken's V	Categories of Validation
1	Suitability of material to curriculum	5	4	5	4.67	0.67	Valid
2	Quality and depth of material	5	5	4	4.67	0.67	Valid
3	Relevance of material to TPACK	5	5	5	5	1.00	Highly Valid
4	Completeness and diversity of project examples	4	5	4	4.33	0.50	Valid
5	Clarity and readability of material	5	4	5	4.67	0.67	Valid
Total Score				**23.34**	**0.67**	**Valid**	

With an Aiken's V value of 0.67, the results of the material validation indicate that the material compiled has good quality and high relevance to the curriculum and the TPACK approach. This indicates that the material can be easily applied to improve students' creative thinking skills, especially in project-based learning.

3. Media and Language Validation

Media and language validation aims to assess the suitability of the media to the learning objectives, the quality and clarity of the media (visual and audio), the consistency of the media design with the material, the use of easy-to-understand language, and the presentation of instructions and explanations in clear language. Table 3 shows the media and language validation results with an Aiken's V value of 0.74, which is included in the valid category.

Table 3: Results of Media and Language Validation

No.	Assessed Aspects	Validator 1 (Score)	Validator 2 (Score)	Validator 3 (Score)	Average of Score	Aiken's V	Categories of Validation
1	Media suitability to learning objectives	5	5	5	5	1.00	Highly Valid
2	Quality and clarity of media (visual and audio)	4	5	4	4.33	0.50	Valid
3	Consistency of media design with material	5	5	5	5	1.00	Highly Valid
4	Use of easy-to-understand language	5	4	5	4.67	0.67	Valid
5	Presentation of instructions and explanations in English	5	5	4	4.67	0.67	Valid
Total Score				**23.67**	**0.74**	**Valid**	

Based on the results of this validation, the media used in the teaching materials are by the learning objectives and have good quality. The use of easy-to-understand language and the presentation of clear instructions are strengths in ensuring that students can easily access teaching materials. Based on the validation results carried out by three validators on three main aspects (instructional design, materials, and media and language), project-oriented TPACK-based teaching materials showed very good to good validity, with Aiken's V values ranging from 0.67 to 1.00. Thus, these teaching materials can be accepted and used in the learning process in universities, significantly improving the creative thinking skills of prospective elementary school teacher students.

2. Results of the Practicality Test of Project-Oriented TPACK-Based Teaching Materials

The practicality test was conducted to assess the extent to which the developed teaching materials can be used effectively by prospective PGSD teacher students in the context of project-based learning. The practicality test involved 30 students who took part in a trial of using teaching materials for two weeks. Practicality test data were collected through a

questionnaire containing ten statements that measure the practicality of the teaching materials in terms of ease of use, completeness of information, clarity of instructions, and relevance to project-based learning.

Practicality Test Data

Table 4 shows the results of the questionnaires filled out by 30 students regarding the practicality of TPACK-based teaching materials. The assessment scores used a Likert scale with the following categories: 1 = Very Impractical, 2 = Impractical, 3 = Quite Practical, 4 = Practical, and 5 = Very Practical. The average score was calculated for each statement.

Table 4: Results of the Practicality Test of Teaching Materials

No.	Statements	Average Score (n=30)	Practically Categories
1	Teaching materials are easy to understand and use by students	4.7	Highly practical
2	The materials presented are relevant to the learning objectives	4.8	Highly practical
3	The instructions in the teaching materials are clear and easy to follow	4.6	Highly practical
4	The steps in the project are easy to follow	4.5	Practical
5	The teaching materials facilitate the development of creative thinking skills	4.7	Highly practical
6	The use of media in the teaching materials is effective and supports learning	4.5	Practical
7	The teaching materials encourage active student participation	4.6	Highly practical
8	The presentation of project examples is relevant to the learning context	4.7	Highly practical
9	The teaching materials are easy to access and use outside the classroom	4.3	Practical
10	The teaching materials as a whole facilitate the project-based learning process	4.8	Highly practical

Based on the questionnaire results, the project-oriented TPACK-based teaching materials are efficient to use in the context of learning. The average practicality score of the teaching

materials is 4.6, which indicates that these teaching materials are included in the highly practical category.

The results of the practicality test show that most students feel that these TPACK-based teaching materials are beneficial in the project-based learning process. The following is a further discussion of the results of the practicality test:

a. Ease of Use and Understanding: The questionnaire results show that the teaching materials are easy for students to understand and use, with an average score of 4.7. This indicates that the design of the teaching materials is very effective in conveying material and instructions and can be quickly followed by students.
b. Relevance of Material to Learning Objectives: Most students (score 4.8) stated that the material in the teaching materials is very relevant to the learning objectives. These teaching materials present theories related to project-based learning and provide factual examples and applications that make it easier for students to understand the concepts taught.
c. Clarity of Instructions: The instructions in the teaching materials were considered straightforward and easy to follow, with an average score of 4.6. Clarity of instructions is one of the important factors in supporting the success of project-based learning because students need to understand the steps that must be taken in completing the project.
d. Relevance of Projects to Learning: Most students (score 4.7) felt that the project examples were relevant to the learning context and could help them develop creative thinking skills. This teaching material provides theoretical guidance and practical activities that can be applied in everyday life.
e. Use of Media in Teaching Materials: The media used in the teaching materials were considered adequate and supported learning, with a score of 4.5. The media used enriched the students' learning experience and allowed them to understand the concepts taught better. These media included images, videos, and infographics from the material provided.
f. Accessibility and Use Outside the Classroom: Although most students considered this teaching material easy to access (score 4.3), some students still wanted further ease of access, for example, in the form of a more user-friendly application or platform. However, the existing access is sufficient to support students to utilize teaching materials outside the classroom.

Overall, the results of the practicality test indicate that project-oriented TPACK-based teaching materials can be used well in the context of project-based learning. These teaching materials provide an in-depth learning experience for students and support the development of creative thinking skills by implementing relevant and easy-to-follow projects. Based on the results of the practicality test conducted, project-oriented TPACK-based teaching materials are considered very practical for use by prospective PGSD teacher students. These teaching

materials effectively support project-based learning and can help students develop creative thinking skills. With an average score of 4.6, these teaching materials are expected to be widely applied in educational programs to improve student skills' quality of learning and development.

3. Test of Effectiveness of Development Results

After implementing the teaching materials, an effectiveness test was conducted using paired samples t-test on 215 students who took the pre-test before using the teaching materials and the post-test after the teaching materials were implemented. The table below shows the descriptive statistics of the pre-test and post-test scores obtained by students:

Table 5. Statisticts of Pre-test dan Post-test Score

Statisticts	Pre-test	Post-test
Total Samples (N)	215	215
Mean	56.8	72.4
Std. Deviation	10.5	8.2
Std. Error Mean	0.7	0.6
Minimum	35	50
Maximum	78	90

Overall, there was a significant increase between the pre-test and post-test scores, with the average post-test score (72.4) being higher than the average pre-test score (56.8). Table 6 shows the results of the paired samples t-test.

Table 6. Results of Paired Samples t-test

Pair	Mean Difference	Std. Deviation	Std. Error Mean	t-value	df	Sig. (2-tailed)
Pre-test - Post-test	-15.6	12.2	0.83	-18.78	214	0.000

The t-test results show that the p-value = 0.000, which is smaller than 0.05, so it can be concluded that there is a significant difference between the pre-test and post-test scores. This

shows that applying project-oriented TPACK-based teaching materials effectively improves students' understanding and skills.

Based on the results of the effectiveness test that has been carried out, it was found that using project-oriented TPACK-based teaching materials positively improves students' creative thinking skills. The average score of students on the post-test was higher than the pre-test, which shows that these teaching materials have improved students' understanding and skills in project-based learning. The significant mean difference value (-15.6) and the t-test results showing p-value = 0.000 support the hypothesis that TPACK-based teaching materials effectively improve students' creative thinking skills. This is in line with the findings of previous studies showing that the TPACK-based approach can encourage the development of creative and problem-solving skills among prospective teacher students.

The significant increase in scores can be explained by implementing the project approach in the teaching materials, which allows students to learn actively and develop creative ideas and solutions. This approach allows students to apply the theories learned in real situations, thus increasing their understanding of the material being taught and encouraging them to think creatively. However, although the study's results showed significant success, several external factors, such as the level of student motivation and the quality of interaction in the project group, may also affect the results. Further research is needed to explore other variables that may affect the effectiveness of TPACK-based teaching materials in the context of project learning.

Overall, this study shows that project-oriented TPACK-based teaching materials are proven to be effective in improving the creative thinking skills of prospective Elementary School teacher students. The results of the effectiveness test using the t-test showed a significant increase between the pre-test and post-test scores, indicating that the teaching materials successfully improved students' understanding of the material being taught and their creative thinking skills.

CONCLUSION

Developing project-oriented TPACK (Technological Pedagogical Content Knowledge)-based teaching materials has proven valid and effective in fostering creative thinking skills in prospective elementary school educators. This approach holistically combines technology, pedagogy, and content, allowing prospective educators to understand how the three components interact in the learning process. Project orientation provides an authentic learning experience, encouraging students to solve problems, innovate, and apply concepts in real situations. The results of the study showed that teaching materials designed with this approach improve critical thinking skills, flexibility in thinking, and the ability to generate new ideas that are relevant and original. In addition, this approach increases prospective

educators' active involvement and learning motivation because they are directly involved in the exploration and collaboration process. By preparing creative and adaptive prospective educators, this approach not only supports the improvement of their professional competence but also contributes to the development of basic education that is more innovative and responsive to the challenges of the times. Therefore, implementing project-oriented TPACK-based teaching materials must be continuously encouraged, accompanied by adequate training and technical support, to ensure its implementation runs optimally. These findings provide a strong basis for developing more progressive educational policies and practices, particularly in preparing educators capable of delivering quality 21st-century learning.

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