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The Development of Teaching Materials Based on Project-Oriented TPACK Approach to Improve the Creative Thinking Skills of Elementary School Teacher Prospective Students

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Abstract

This study aimed to produce project-oriented TPACK-based teaching materials (Technology Pedagogical Content Knowledge) that can improve the students' creative thinking skills of elementary school teacher prospective students. This research used development research method (RnD) which was adapted from Borg & Gall. There were 10 Borg & Gall development procedures which are modified into 8 stages which were adapted to the conditions in the field. The results showed that the project-oriented TPACK-based teaching materials were suitable for use in learning with valid, practical, and effective criteria. The validation results from the average value of the expert validator of teaching materials and learning technology media show that teaching materials are considered valid both in terms of construct and content. Observations on the activity of lecturers and students which increased at each meeting indicated that practical teaching materials were applied in learning, as well as the results of students' creative thinking skills tests showed that teaching materials were effective in increasing the students' creative thinking skills of prospective teacher. The implication of this research is the use of the right method can affect the achievement of creative thinking skills of students to be able to

propose various alternative problem solving. The suggestions for further research are developing project-oriented TPACK-based teaching materials for elementary school students.

Keywords: Teaching Materials, TPACK, Projects, Creative Thinking Skills.

Abstrak

Penelitian ini bertujuan untuk menghasilkan bahan ajar berbasis TPACK (Technology Pedagoogical Content Knoelwdge) berorientasi proyek yang dapat meningkatkan keterampilan berpikir kreatif mahasiswa calon guru sekolah dasar. Penelitian ini menggunakan metode penelitian pengembangan (RnD) yang diadaptasi dari Borg & Gall. 10 prosedur pengembangan Borg&Gall kemudian dimodifikasi menjadi 8 tahapan yang disesuaikan dengan kondisi di lapangan. Hasil penelitian menunjukkan bahwa bahan ajar berbasis TPACK berorientasi proyek layak digunakan dalam pembelajaran dengan kriteria valid, praktis, dan efektif. Hasil validasi yang didapatkan dari rerata nilai validator ahli bahan ajar dan media teknologi pembelajaran menunjukkan bahwa bahan ajar dinilai valid baik dari segi konstruk maupun konten. Hasil pengamatan aktivitas dosen dan mahasiswa yang meningkat di setiap pertemuan menunjukkan bahwa bahan ajar praktis diterapkan dalam pembelajaran, serta hasil tes keterampilan berpikir kreatif mahasiswa menunjukkan bahwa bahan ajar efektif untuk meningkatkan keterampilan berpikir kreatif mahasiswa calon guru. Implikasi penelitian ini adalah penggunaan metode yang tepat dapat berpengaruh terhadap pencapaian kemampuan berpikir kreatif calon guru untuk dapat mengemukakan berbagai alternatif pemecahan masalah. Adapun saran bagi penelitian selanjutnya yaitu mengembangkan bahan ajar berbasis TPACK berorientasi proyek bagi siswa sekolah dasar.

Kata Kunci: *Bahan Ajar, TPACK, Proyek, Keterampilan Berpikir Kreatif*

INTRODUCTION

Challenges in the increasingly dynamic and developing of globalization era require human resources who have high intellectual skills, characterized by logical, systematic, critical, careful, and creative reasoning abilities and have a good attitude in communicating ideas (Antika, 2017). Creative thinking skill is essential skill for the success of a good teacher candidate (Ramdani & Artayasa, 2020). Creative thinking is an effort to generate ideas or something that is unique and new (Greenstein, 2012;

Taylor & Getzels, 2017). Creative thinking or divergent thinking is also related to the ability to see various possibilities in solving problems (Guilford, 1967). Creative thinking in education is needed to open up new ways that contribute to improving the quality of learning (Beghetto & Karwowski, 2018).

However, this skill still need to be optimally improved for prospective teacher students in university. The low creative thinking skills of students are caused by learning in university where the dominant training is knowledge, memory / memorization, the ability to think logically or convergent thinking, namely the ability to find the most appropriate answer to a given problem based on available information (Fatmawati, 2011; Ülger, 2016). Thus, every student becomes accustomed to convergent thinking so that when faced with a problem, they will have difficulty providing several alternative solutions to the problem. This argument is supported by data on the creativity of the Indonesian people based on a survey on the 2015 Global Creativity Index, which ranks 115 out of 139 countries (Florida *et al.,* 2015). Meanwhile, the 2019 Global Innovation Index places Indonesia at 85th place out of 129 countries (Dutta *et al.,* 2020). This result also shows that Indonesia's position is still below that compared to other Southeast Asian and Oceanian countries (Pençe *et al.,* 2019). Improvement efforts that have been carried out by various parties have not had an optimal effect on improving the quality of Indonesian graduates in terms of the creative thinking of prospective teachers. Improvement efforts that have been carried out by various parties have not had an optimal effect on improving the quality of Indonesian graduates in terms of the creative thinking of prospective teachers (Antika, 2017). For this reason, an innovative learning strategy is needed that has the potential to empower students' creative thinking. Innovative learning strategies are inseparable from constructivism in learning which accustoms students to discovering everything on their own and relating to ideas. One of the learning strategies that suit is project-based learning (Guo *et al.,* 2020).

Project-based learning allows students to research, plan, design and reflect on the creation of technology projects according to their fields (Wardani *et al.,* 2021). Instilling creative thinking in students through the project design process not only changes teaching methods and learning environments but also adopts new methods of assessment, such as portfolio assessment. The knowledge gained becomes more meaningful and learning activities become more interesting, because this knowledge is useful for him to better appreciate his environment, understand, and solve

problems faced in everyday life (Fatmawati, 2011; Wardani *et al.,* 2020). With a given project, the development of an inquiry process can occur in various aspects of real topics that students may be interested in. The application of this project-based learning can be realized in a teaching material. According to Prastowo, (2015), teaching materials aim to make it easier for students to learn and make it easier for teachers to convey teaching material through various forms. With teaching materials oriented towards project learning, students can be actively involved in solving complex project problems with real product results and developing new skills in collaborating and managing assignments according to the content.

On the other hand, apart from pedagogy and content, the presence of ICT currently plays an important role in every aspect of learning (Mairisiska *et al.,* 2014). Modern learning as it is today demands 21st century skills that involve communication and collaboration skills as well as the use of information technology in learning. Development of learning by integrating ICT makes a significant contribution to the level of pedagogical practice of students (Brun & Hinostroza, 2014). Teachers are also required to have IT literacy skills in science learning with various methods and approaches to learning in the classroom (Villagrasa *et al.,* 2014) (Ertmer & Ottenbreit-Leftwich, 2010). Recent research explains that successful 21st century learning involves understanding material or content, teaching methods, and utilizing information technology (TPACK) synergistically (Baya'a & Daher, 2015) (Bektas, 2015)(Young *et al.,* 2012). The idea of TPACK also has a close relationship with increased collaboration, accountability, and creative thinking in learning (Joy, 2015). Thus, this research intends to develop TPACK (Technological Pedagogic Content Knowledge)-based and project-oriented learning that is packaged in a teaching material. Similar research was conducted by Mairisiska *et al.,* (2014) who developed a TPACK-based learning tool to improve students' critical thinking skills, a study conducted by Lee & Kim, (2014) developed a TPACK-based learning design model in technology integration courses and Tokmak, (2013) which examines the changes in the perceptions of prospective teachers through the development of TPACK-based materials. However, there are still limited studies that discuss and develop TPACK-based and project-oriented teaching materials to improve students' creative thinking skills, especially prospective elementary school teacher students.

Based on the background above, the researchers focused their study on the development of project-oriented TPACK-based teaching materials to improve the creative thinking skills of Elementary School Teacher Education students. This study aims to produce project-oriented TPACK-based teaching materials that are feasible to use with valid, effective, and practical criteria applied in lectures.

METHODS

This research uses the research and development (R&D) method adapted from Borg & Gall. According to Borg, W.R. & Gall, (1989), R&D is a process used to develop and validate educational products. The results of development research are not only the development of an existing product but also to find knowledge or answers to practical problems. Through development research, researchers try to develop a product that is suitable used in learning. The product produced in this study is in the form of project-oriented TPACK-based teaching materials to increase technology awareness and creative thinking skills of primary teacher education students. The Borg & Gall (1989) development procedure has 10 stages consisting of: (1) initial research and information gathering, (2) planning, (3) initial product format development, (4) initial trial (5) initial product revision, (6) Test field trials, (7) product revisions, (8) Validation and field trials, (9) Final product revisions, and (10) Dissemination and implementation (Borg, W.R. & Gall, 1989).

The development procedure was modified by the researchers into 8 stages which were adjusted to the needs and conditions in the field. The steps include: (1) research and initial information gathering, consisting of literature studies related to the problems studied and preparation for formulating a research framework, (2) planning, consisting of steps to formulate draft teaching materials and determine the TPACK and project components in teaching materials, (3) development of initial product formats, consisting of steps to develop initial drafts, expert validation, preparation of supporting components, preparing learning tools, and evaluating the feasibility of supporting tools, (4) initial trials that are limited in nature, (5) Revision of the initial product, (6) Validation and field testing of the teaching materials that have been produced, (7) Revision of the final product, and (8) Dissemination and implementation. The trial design used a one group pretest-posttest design with a

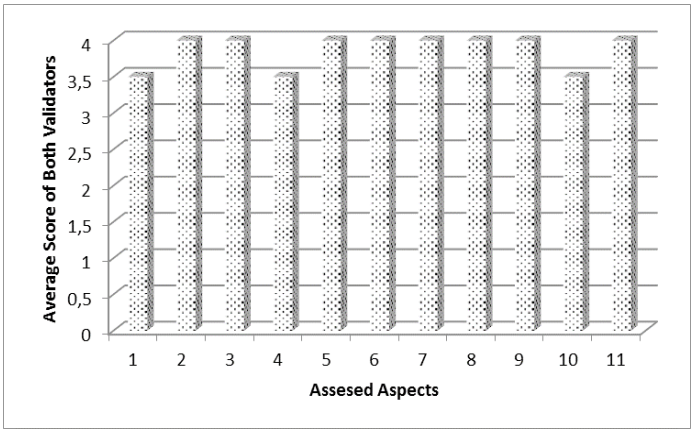
sample of 157 students. The research instruments consist of; 1) expert validation sheet, 2) observation sheet of SAP implementation in lecturer and student activities, and 3) student creative thinking skills test sheet. The data analysis technique used is qualitative and quantitative data analysis techniques. Qualitative data analysis consisted of data reduction, data presentation, and conclusions, while quantitative data analysis consisted of normality test, homogeneity test, and t-test for creative thinking skills test results.

The indicators of creative thinking skills measured in this study follow the indicators of Treffinger & Isaksen, (2005), namely fluency (generates a large number of ideas), flexibility (generates ideas that are varied, logical, relevant, and come from several different points of view), originality (generate ideas that are relatively new, unique, and appropriate to the problem), and elaboration (generate ideas that are equipped with specific, complete, and interesting details).

RESULTS AND DISCUSSION

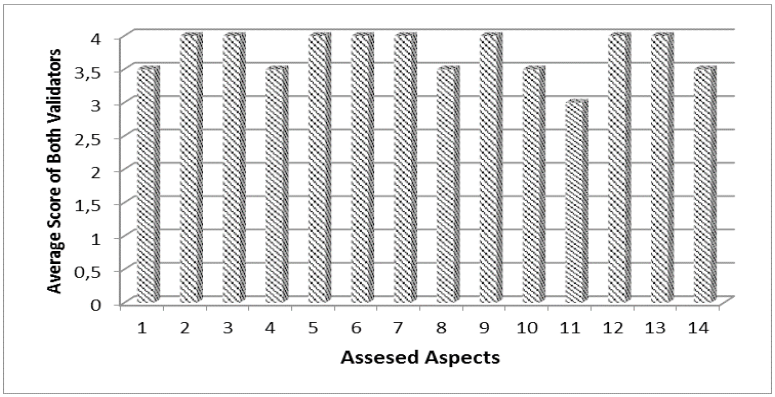
Teaching Material Validity

The validity of the developed teaching materials was obtained from the average scores of the two validators on the presentation, language, graphic, and content components. The results of the average validation score on the presentation aspect can be seen in Graph 1.



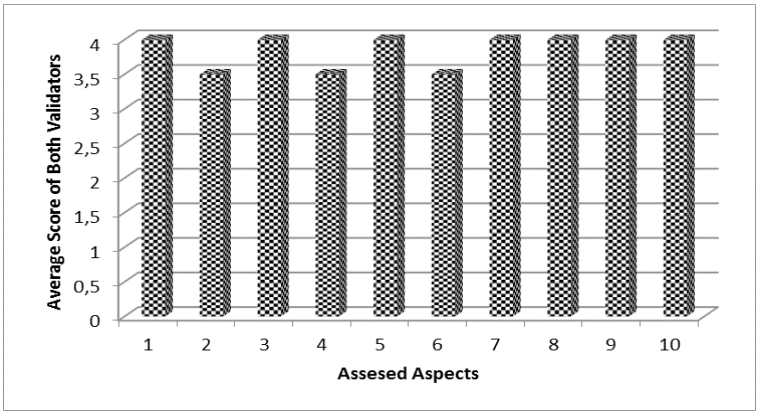
Graph 1. The Results of the Average Score Validation Aspects of Presentation

Based on Graph 1, it can be seen that the development of teaching materials from the presentation aspect results in an average validation score of 4 with a valid category on 8 out of 11 aspects. Thus, the construct validity of the TPACK-based teaching material presentation component can be scientifically proven. Then for the results of the average validation score on the linguistic aspect can be seen in Graph 2.



Graph 2. The Results of the Average Score of Language Aspect Validation

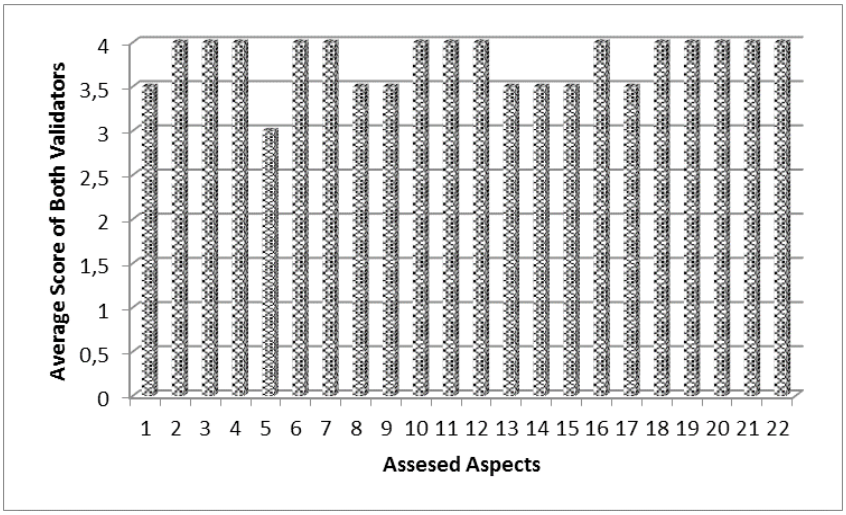
Based on Graph 2, it can be seen that the development of teaching materials from the linguistic aspect results in an average validation score of 4 with a valid category on 8 out of 14 aspects. Thus, the construct validity of the language components of TPACK-based teaching materials can be scientifically proven. Then for the results of the average validation score on the graphical aspect can be seen in Graph 3.



Graph 3. The Results of the Average Score of Graphical Aspect Validation

Based on Graph 3, it can be seen that the development of teaching materials from the graphical aspect results in an average validation score of 4 with a valid

category on 7 aspects out of 10 aspects. Thus, the construct validity of the graphic components of TPACK-based teaching materials can be scientifically proven. Then for the results of the average validation score on the content aspect or content validation can be seen in Graph 4.

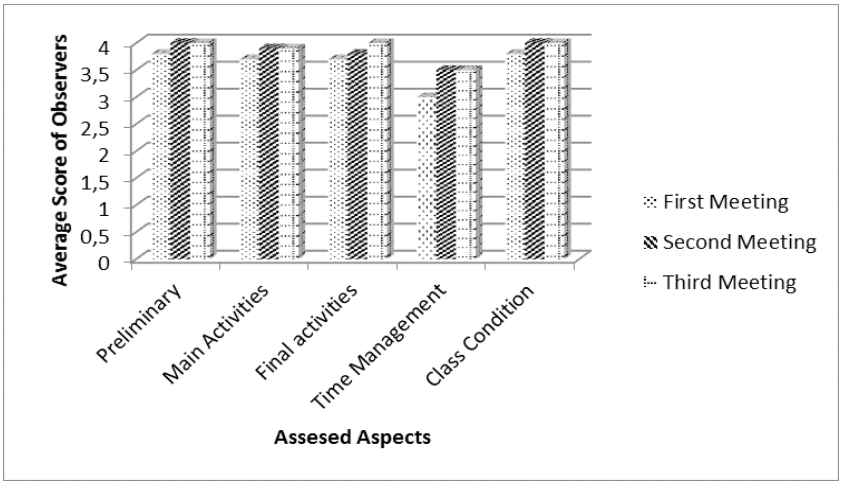


Graph 4. The Results of the Average Score of Content Aspect Validation

Based on Graph 4, it can be seen that the development of teaching materials from the content aspect results in an average validation score of 4 with a valid category on 14 of the 22 aspects assessed. Thus, the content validity of the content components of TPACK-based teaching materials can be scientifically proven.

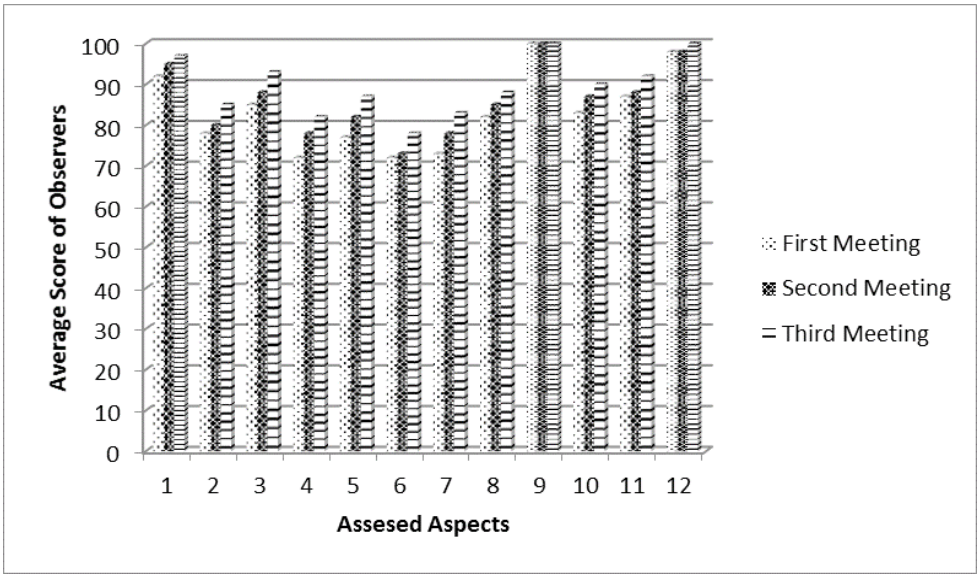
Practicality of Teaching Materials

The practicality of the teaching materials in this study can be seen from the results of the average score of the two observers in the implementation of SAP (Lecture Program Unit) lecturer and student activities in lectures that apply project-oriented TPACK-based teaching materials. The results of the average score of observers on the implementation of lecturer activities are presented in Graph 5.



Graph 5. The Results of Mean Scores of Observers for the Implementation of Lecturer Activities in Three Meetings

Graph 5 shows that lecturer activities have increased from the first meeting to the third meeting, namely obtaining an average score of 4 in the "good" category in 3 of the 5 aspects assessed in the second and third meetings. Overall all the stages in SAP at all meetings can be carried out in the "good" category. The results of the average score of observers on the implementation of student activities are presented in Graph 6.



Graph 6. The Results of Average Scores of Observers of the Implementation of Student Activities in Three Meetings

Graph 6 shows that all stages of student activity in the second and third meetings achieved an average score of >75 in the "active" category and experienced an increase in activity from the first meeting to the third meeting. Thus, the application of TPACK-based and project-oriented teaching materials can be scientifically proven in terms of practicality.

The Effectiveness of Teaching Materials

The effectiveness of implementing TPACK-based and project-oriented teaching materials can be seen from the results of the pretest and posttest of creative thinking skills which are assessed with an assessment rubric and then presented in the form of numbers. The results of the students' pretest and posttest scores were then tested inferentially using the t-test of two paired samples which were previously tested for normality using the Kolmogorov-Smirnov test with a Sig value of > 0.05, which is 0.231. These results indicate that the data is normally distributed. The results of the t-test for two paired samples are then presented in Table 1.

Table 1. The results of the t-test on Creative Thinking Skills

Data	t arithmetic	t table	Sig.	Decision
Pretest and posttest on creative thinking skills	(-)19,944	2,045	0,000	There is a difference

The data in Table 1 shows that the t-test of students' creative thinking skills data at a significance level of 0.05 obtained t arithmetic = 19.944 > t table = 2.045 so that H0 is rejected and Ha is accepted. Thus there is a mean difference between the pretest and post test results. The t count is negative because the average value of pretest creative thinking skills is lower than the average post-test results. So as the results above, it can be concluded that there was an increase in the pretest and post-test results of students' creative thinking skills by applying TPACK-based and project-oriented teaching materials. Thus the application of TPACK-based and project-oriented teaching materials can be scientifically proven in terms of effectiveness.

According to Nieveen, (1999), the quality of the development of a learning material product must meet the criteria of validity, practicality, and effectiveness. A product is valid if it is developed in accordance with the material (content validity)

and all components are connected to each other consistently (construct validity) and they are declared fit for use with revisions or without revisions by the validator (Plomp, 2013). This TPACK-based and project-oriented teaching material is assessed for validity from four aspects of feasibility, namely the feasibility of presentation, language, graphics, and content. Graph 1 shows that the development of teaching materials from the presentation aspect results in an average validation score of 4 with a valid category on 8 out of 11 aspects. One aspect of the presentation component that is rated as valid is the support for the presentation of the material. The presentation of the material in this teaching material is supported by the elements in TPACK which are understandings that emerge from the interaction of knowledge, content, pedagogy, and technology. The ideal TPACK teaching materials consist of knowledge about concepts, theories, ideas, frameworks, real knowledge, evidence, laws, principles, practices, curricula, assessments, learning outcomes, and approaches to develop that knowledge which is then supported by the integration of technology (Huda *et al.,* 2017). Graph 2 also shows that the language components of TPACK-based teaching materials can be scientifically proven. The linguistic aspect of textbooks is one of the factors that determines whether textbooks are good quality or not. This is consistent with Tegeh *et al.,* (2015) statement that one of the characteristics of a good textbook is using good and easy-to-understand language. Then Graph 3 shows that the graphical component is considered valid by the validator. The validity of the graphical components in the developed teaching materials is supported by the provision of appropriate illustrations and font sizes so as to increase students' understanding of reading in teaching materials (Rizal, 2012). The same thing is also found in content validation. The teaching materials developed in content have met the requirements relevant to scientific principles, namely they are in accordance with basic education scientific principles, have provided a need for student learning outcomes and each component in the teaching materials has been based on strong theoretical arguments about integrating TPACK and creative thinking skills.

The application of TPACK-based and project-oriented teaching materials has also been scientifically proven in terms of practicality and effectiveness. The results of observing the implementation of lecturer and student activities in Graph 5 and 6 show an increase in lecturer and student activity from the first meeting to the third meeting. The highest aspect of the lecturer's activities is shown in the core lecture

activities, because in this core activity, the lecturer applies TPACK-based learning using teaching materials that have been developed to train students' creative thinking skills. Effective technological integration for pedagogy regarding lecture material does indeed require developing sensitivity to dynamic, transactional relationships between components of knowledge located in unique contexts to enhance students' creative thinking skills (Nugroho *et al.,* 2019). Equally important is the data in Table 1 which shows the effectiveness of project-oriented TPACK teaching material products which are proven to be able to improve students' creative thinking skills. This is because learning is carried out using two main approaches, namely process and product. In the process approach, the lecturer stimulates students to respond to problems and solve them using appropriate methods, in this case, the process of creative thinking starts from students knowing there is a problem to communicating the results of their thoughts (Kardoyo *et al.,* 2020). Then in the product or result approach, Treffinger & Isaksen, (2005) suggests that creative thinking emphasizes aspects of fluency (producing a large number of ideas), flexibility (producing ideas that are varied, logical, relevant, and come from several different points of view), originality (generate ideas that are relatively new, unique, and appropriate to the problem), and elaboration (generate ideas that are equipped with specific, complete, and interesting details).

The application of project-oriented TPACK-based teaching materials that are proven to be valid, practical, and effective is in line with a study conducted by (Ismawati *et al.,* 2014) that learning should also be able to understand concepts and not just memorize. Efforts to increase TPACK are also in accordance with research conducted by Ismawati *et al.,* (2014) and Ertmer & Ottenbreit, (2010) that lecturers as teachers are also required to have IT literacy skills in learning with various methods and approaches to learning in the classroom. Thus, it is hoped that prospective teacher students will be able to think convergent and divergently by looking at various possibilities in solving problems and based on existing evidence and data so that they can contribute to improving the quality of future learning in the classroom.

CONCLUSION

The development of project-oriented TPACK-based teaching materials to improve the creative thinking skills of prospective teacher students is proven to be suitable for use in learning with valid, practical, and effective criteria. The results of content and construct validity show that the developed teaching materials meet valid criteria in terms of presentation, language, graphics, and content. The results of observations of lecturer and student activities that increase in each meeting show that practical teaching materials are applied in learning and are proven to be effective in improving the creative thinking skills of prospective teacher students. Thus, valid, practical, and effective criteria indicate that the developed teaching material product is suitable for use in learning. What can be developed as a follow-up study from this research is the development of project-oriented TPACK-based teaching materials for elementary school students.

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