Journal for Lesson and Learning Studies
Volume 7, Number 2, 2024 pp. 212-220
P-ISSN: 2615-6148 E-ISSN: 2615-7330
Open Access: https://doi.org/10.23887/jlls.v7i2.74482

Project-Based Learning with Paired Expert and Beginner Models to Develop Innovative Thinking Skills

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ARTICLE INFO

Article history:
Received January 20, 2024
Accepted June 20, 2024
Available online July 25, 2024

Kata Kunci:
Pembelajaran - Berbasis Proyek, Pakar, Pemula, Berpikir Inovatif

Keywords:
Project – Based Learning, Expert, Beginner, Innovative Thinking

ABSTRAK

Mahasiswa pada program Magister Pendidikan Dasar memiliki latar belakang yang beragam. Namun demikian, kemampuan inovatif belum tumbuh karena pengalaman mengajar belum diiringi dengan pengalaman menggunakan teknologi dan sebaliknya. Penelitian ini bertujuan untuk mengembangkan kemampuan berpikir inovatif mahasiswa melalui sebuah model pembelajaran yang yaitu pembelajaran berbasis proyek dengan model pakar pemula berpasangan. Jenis penelitian ini adalah pra-eksperimen dengan sampel yaitu mahasiswa Magister Pendidikan Dasar sebanyak 38 mahasiswa. Pengisian kuisioner digunakan untuk menilai perspektif mahasiswa pada kemampuan berpikir inovatif sebelum dan sesudah perlakuan dan rubrik penilaian untuk menilai produk. Data dari kuisioner dianalisis menggunakan uji t dan produk yang dihasilkan dianalisis secara deskriptif kuantitatif. Berdasarkan hasil analisis data dapat disimpulkan bahwa kemampuan berpikir inovatif dapat dikembangkan. Dari kelima aspek kemampuan berpikir inovatif, kerja tim merupakan aspek yang meningkat sangat baik. Hasil penyelesaian proyek menunjukkan rata-rata kemampuan berpikir inovatif sudah berkembang dengan baik. Lingkungan belajar yang kontekstual dengan menghadirkan permasalahan nyata terkait dengan proses pembelajaran siswa di sekolah dasar mampu menstimulus kemampuan mahasiswa dalam memecahkan masalah. Pemecahan masalah juga dilakukan dengan baik karena beragamnya latar belakang individu dalam kelompok saling berkontribusi dan bekerja sama dengan baik.

ABSTRACT

Students in the Master of Basic Education program have diverse backgrounds. However, innovative abilities have not grown because teaching experience has not been accompanied by experience using technology and vice versa. This study aims to develop students' innovative thinking skills through a learning model that is project-based learning with a paired novice expert model. This type of research is pre-experimental design with a sample of 38 Master of Basic Education students. Questionnaire filling was used to assess students' perspectives on innovative thinking skills before and after treatment and an assessment rubric to assess the product. Data from the questionnaire was analyzed using the Wilcoxon test and the resulting product was analyzed descriptively quantitatively. Based on the results of data analysis, it can be concluded that innovative thinking skills can be developed. Teamwork is an aspect that has improved very well compared to the other four aspects of innovative thinking skills. The results of project completion show that on average, innovative thinking skills have developed well. The contextualized learning environment by presenting real problems related to the learning process of students in elementary schools is able to stimulate students' ability to solve problems. Problem solving is also done well because the diverse backgrounds of individuals in the group contribute to each other and work well together.

1. INTRODUCTION

Learning in the 21st century today continues to be encouraged so that graduates can adapt to changes in the real world, which is very dynamic. Students are not only encouraged to succeed academically but also productive at work and can contribute significantly to the surrounding community. Such success requires higher-order thinking skills and complex thinking processes (Goyal et al., 2022; Tijsma et al., 2020). Thus, it needs learning that leads learners to collaborate and build networks and

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learning communities. A study explains that team diversity in project-based learning is influential in achieving innovation (Stolaki et al., 2023; Usher & Barak, 2020). The variety of teams, from the aspects of knowing each other, the ability to provide support, mutual trust, and nonverbal communication, turned out to influence creation of project innovations (Wullschleger et al., 2023; Zehui et al., 2019). Diversity is inseparable in life. There were several student backgrounds in courses on developing integrated teaching materials in primary education, such as senior practitioners, principals, mentors in tutoring, fresh graduate students, and even junior teachers. Diversity provides opportunities for information exchange. The existence of differences in experience and level of knowledge about integrated learning needs to be facilitated so that all students can show maximum performance during the learning process.

Social interaction during the learning process facilitates the building of new knowledge. Learners develop communication skills and the use of symbols while interacting with other individuals who have very diverse cultures. In addition, cognitive development also occurs when learners collaborate with their peers and adults (Medeiros et al., 2023; Smieskova, 2017). This aligns with a study that collaboration increases the ability to explore and develop ideas and questions that create new knowledge and practices (Wong et al., 2021). Project-based learning is effectively used in teaching, prioritizing direct experience in solving contextual problems. Through the project, students can connect between theory and practice. Based on this authentic experience, students can get their hard and soft skills. Projects conducted outside the classroom train students to prepare for the world of work with soft skills in teamwork, project management, communication skills, interpersonal skills, and problem-solving (Gomez-del Rio & Rodriguez, 2022; Lobczowski et al., 2021). Students can also integrate knowledge through project-based learning. Through the meta-analysis method, project-based learning is proven to help learners achieve learning goals that lead to creativity and problem-solving, critical thinking, collaboration, and communication (Goyal et al., 2022; Liu, Y., & Pasztor, 2022).

There are seven characteristics of project-based learning. First, at the beginning of learning, a stimulus question is given to solve. Second, students focus on learning objectives that require mastering the main concepts and assessments. Third, the problem of a lighter or stimulus is solved through the scientific method and requires students to apply essential ideas related to the science occupied. Fourth, there is collaboration between students, teachers, and the surrounding community during problem-solving. It encourages a person to be an expert in problem-solving. Fifth, students are given guidance through learning technology during the investigation process. Sixth, students create a work relevant to the problem at the beginning of learning (Miri Barak & Yuan, 2021; Gandi et al., 2019). Project-based learning involves teams with diverse characteristics. Collaboration between groups is not even an easy thing. The team must be able to manage the project sufficiently to be able to achieve common goals. Differences in knowledge in organizing teamwork strategies also cause project learning outcomes to be massive (Lobczowski et al., 2021; Terán-Bustamante et al., 2021). However, collaboration can be a medium for team members with the same ability to create creative collaboration marked by challenging and developing questions, applying theory during the development process, or collaboration (Shanks et al., 2017; Wong et al., 2021). According to the Zone of Proximal Development (ZPD) theory, there will be maximum development with assistance from both peer tutors and older people. In this 21st century learning, innovation is one of the prominent skills (Atasoy et al., 2023; Hughes et al., 2018). The ability to think innovation can develop starting with responding to issues, the consequences caused by changing times, imbalances in technological development, or inequality and environmental crises. The formal learning process can facilitate learners to expand their knowledge and build innovations locally and globally. Innovation itself cannot be separated from investigations or research that test models or ways to translate knowledge into meaningful initiatives (Asrizal & Utami, 2021; Lytras et al., 2022).

Thinking innovatively is the ability to overcome challenges and opportunities creatively by utilizing engineering skills, knowledge, and theory. This ability is shown by imagining and thinking with various scientific approaches, interpretation, and integration (Avcı & Durak, 2023a; Hasanah & Supriansyah, 2022). There are several consistent behavioral traits possessed by someone who can think innovatively, namely, not reluctant to ask, observe, try, and explore networks of ideas. First, a person can cooperate with people from various backgrounds and views. Second, the ability to collaborate globally. Through diverse scientific backgrounds, it encourages someone to explore multiple experiences, knowledge systems, and various ways of thinking. In addition, there are characteristics such as problem-solving, establishing cooperation, contributing to the surroundings, seeking the latest innovations, and always wanting to learn (Miri Barak & Yuan, 2021; Homan et al., 2020). Innovation is influenced by the diversity of disciplines and academic levels owned by team members. Innovation can be done with collaboration. For example, learning is connected with internship experience in industry. In addition to completing tasks in their projects, learners can innovate based on their knowledge gained during internships in the industrial world. Innovation can grow in experiential learning environments (Juraschek

et al., 2020; Usher & Barak, 2020). The ability to think innovatively using instruments developed from previous research consists of five indicators: creative problem-solving, thinking systems, goal orientation, teamwork, and networking (Keinänen et al., 2018).

Based on observations at the beginning of lectures, it is evident that there is a gap between students with long experience being teachers and those still involved as junior teachers or even fresh graduates in responding to problems presented by lecturers. However, proficiency in the use of technology applies the other way around. Students who are junior teachers and fresh graduates are more proficient in utilizing technology. Concerning the Integrated Teaching Material Development course in Basic Education with the target of producing innovative products according to thematic learning problems in schools, researchers have ideas for lectures arranged in such a way in project-based learning that groups students with information and technology skills and diverse teaching experiences. Based on the importance of innovation in 21st-century learning, it becomes a skill that must be highlighted (Hughes et al., 2018; Juraschek et al., 2020).

A study also explains that innovation is influenced by the diversity of disciplines and academic levels owned by team members. In addition, innovation can grow in experiential learning environments. Thus, conducting research entitled Project-based learning with a paired expert-beginner model is necessary to develop innovative thinking skills. These differences in expertise are expected to complement each other so that students can solve a real problem in thematic learning with innovative works. The formulation of the situation in this study is how the innovative thinking ability of students is viewed from the results of project-based learning and how the perception of students' innovative thinking skills before and after project-based learning is implemented with the model of expert – beginners in pairs. This study aims to develop students' innovative thinking skills in overcoming integrated learning problems in elementary schools. The ability to think innovatively is also supported by the work created by students during project-based learning. The novelty of this study contributes significantly through their thoughts and actions to solve integrated learning problems. At the end of this research, students are expected to produce innovative work that can be applied in primary education.

2. METHOD

This study used pre-experimental design with one group pre–and post–test design. This study involved 38 postgraduate's student of primary education. Data collection is carried out in two ways: by filling out questionnaires on perception ability to think innovatively before and after learning and assessing project results using the assessment rubric. The instrument in the form of a questionnaire adopts an innovative thinking ability measurement instrument (Keinänen et al., 2018). The researcher develops the rubric for assessing project results. Assessment rubric covering aspects of problem-solving and new ideas in producing innovative products. Innovative products are created based on improvements from existing products by utilizing the latest technological developments per user needs or to solve user problems (Ramatsetse et al., 2023). The preparation of instruments, especially the rubric of assessing project results, refers to innovative product indicators, which include product suitability to the problems found, products designed according to needs, products designed by utilizing technological advances, attractively presented products, and products that facilitate students to develop 21st-century learning abilities. Experts validate the instrument to obtain content validity (suitability between the aspects to be measured and the measurement indicators, then the suitability of each indicator with its assessment criteria). The inputs provided by validators are: 1) assessment indicators need to be added for aspects of suitability with integrated learning, and 2) assessment criteria need to be considered in the gradation of the assessment so that each criterion can be clearly understood.

Thus, the assessment rubric, which initially only included five assessment indicators, increased to 6 indicators, namely product suitability to problems found in the field, product suitability designed to the needs of students, product suitability in supporting integrated learning in elementary schools, the product created by utilizing technological advances, product attractiveness, and products facilitating students to develop 21st-century learning skills. Perceptual data on innovative thinking skills were analysed using the Wilcoxon signed ranks test because the data were normally distributed but not homogeneous. At the same time, the results of the assessment of innovative products are analysed descriptively and categorized into five categories.

3. RESULT AND DISCUSSION

Result

Students taking the Integrated Teaching Material Development in Basic Education course are given questionnaires before and after project-based learning to assess their perceptions of innovative thinking skills before and after interventions. The normality test results using the Kolmogorov-Smirnov test show that the data are normally distributed. However, when the homogeneity test was carried out, the data variance was not homogeneous, so the data was analyzed using the Wilcoxon Signed Rank Test. The Wilcoxon Signed Ranking Test results show a significance value of less than 0.05. The results showed that students' perceptions of innovative thinking skills differed significantly between before and after project-based learning with the expert beginners paired model. When analyzed descriptively, each indicator of innovative thinking ability at the post-test is included in the excellent category with details in Table 1.

Table 1. Table of Descriptive Analysis Results of Perception of Innovative Thinking Ability

No	Indicator	Average of Pre-test	Category	Average of Post-test	Category
1	Creative problem solving	2.5	Good enough	3.5	Very good
2	Thinking Systems	2.6	Good enough	3.5	Very good
3	Goal orientation	2.7	Good enough	3.6	Very good
4	Teamwork	2.8	Good enough	3.8	Very good
5	Networking	2.3	Good enough	3.6	Very good

In addition to being assessed from perception, the ability to think innovatively is also evaluated from the projects that students in groups with expert and novice pairs have done. Teaching materials designed by students have different themes according to the problems obtained during observation in elementary school. The articles intended are Me and My New Friend, People, and Inventions, Heat Transfer Around Us, Entrepreneurship, Grilled Sausages, Save Living Things, Solutions for the Neatness of My Home, and Our Friend's Environment. Teaching materials developed as student worksheets, modules, and picture stories. Table 2 shows the results of the assessment using rubrics.

Table 2. Assessment Table of Innovative Thinking Ability Through Project Results

No	Indicator	Group Score									Average	Category
		1	2	3	4	5	6	7	8	9		
1	Suitability of the product to problems found in the field	3.5	3.0	4.0	4.0	3.0	3.5	4.0	4.0	4.0	3.8	Very good
2	Suitability of products designed to the needs of learners	3.0	3.0	4.0	3.0	3.0	3.0	4.0	4.0	4.0	3.4	Very good
3	Product suitability in supporting integrated learning in primary schools	3.0	3.0	3.5	3.0	3.0	3.0	3.5	4.0	3.5	3.3	Good
4	Products are designed by taking advantage of technological advancements	2.5	3.0	4.0	3.0	2.0	3.5	3.5	3.5	3.0	3.1	Good
5	Product attractiveness	3.0	3.0	4.0	3.0	2.0	3.0	3.0	3.5	3.0	3.0	Good
6	Products facilitate students to develop 21st-century learning	2.0	3.0	4.0	2.5	2.5	3.5	4.0	4.0	4.0	3.3	Good

Based on Table 2, the assessment of project results using rubrics and analyzed descriptively, it can be seen that the average of the six indicators of students' innovative thinking ability is included in the excellent category.

Discussion

Based on the results of data analysis obtained from filling out questionnaires, it is known that the perception of students' innovative thinking skills increased after project-based learning with a pair of expert and novice models. This is further reinforced by the results of project assessments in each group, which show a range of values from quite good to very good. The results of this analysis align with previous research state that project-based learning encourages the creation of innovative ideas and successes obtained through project management over a long time (Wiewiora et al., 2020).

The learning process that has been carried out by Master of Basic Education students, especially in the course Development of Integrated Teaching Materials in Basic Education can gradually facilitate in developing innovative thinking skills. Starting with providing a stimulus at the beginning of learning in the form of problems in the application of integrated learning in elementary schools encourages students to dig deeper into the focus of the problems found (Niraula, 2021; Yılmaz, 2021). Based on this stimulus, students are then directed to formulate their learning objectives which are certainly relevant to the learning outcomes of the course. This first stage is one of the strategies so that students are trained to manage the learning process and focus on the problem. This stage is in line with research conducted state that the learning process that provides challenges is able to empower the ability to manage themselves and solve problems and create creative ideas and innovative thinking (Atasoy et al., 2023; Miri Barak & Yuan, 2021; Yudha et al., 2018). This ability certainly arises because students are accustomed to being actively involved from the beginning to the end of the learning process. The problem used as a stimulus in this research is the application of thematic learning in elementary schools that is not in accordance with the principles of integrated learning and has not met the needs of students in elementary schools. The complexity of this problem provides an opportunity for students to actively respond and determine the focus of the problem. As has been researched by other studies state that being someone who is responsive to problems begins with providing complex problems in their learning (Balakrishnan, 2019; Halili, 2019).

Determination of learning objectives that have been mutually agreed upon is followed by the formation of collaborative learning groups. Collaboration between experts and novices in this case is not only to fulfill the heterogeneity aspect in the group but in accordance with the results of research state that cognitive development will be better when there is interaction and cooperation between individuals of the same age or with adults (Medeiros et al., 2023). This research focuses on empowering innovative thinking skills that are facilitated by a variety of skills and levels. In line with the explanation state that innovative thinking skills begin with problem identification followed by evaluation of various solutions that have been implemented and developing new solutions (Usher & Barak, 2020). These efforts are made by students by directly digging up information from teachers in elementary schools and observing the learning process that applies thematic learning. Contextualized learning will be more meaningful because students not only master the concepts of integrated learning but can solve problems and apply them in learning in elementary schools.

During project-based learning with this paired expert-beginner model, students make observations, focus on what problems will be solved, build ideas from the network built, and test them. Observation to find problems is initiated by questions that focus on implementing ideal integrated learning or following its principles (Miri Barak & Yuan, 2021; Homan et al., 2020). The results of observations made both in the learning process, learning documents and interviews with teachers, and providing questionnaires to elementary school students become the basis for students to determine the focus of problems that are important to solve. The stages of learning carried out by students are able to empower innovative thinking skills as well as research that has been conducted the ability to think innovatively is empowered through four stages of learning activities, namely questioning, observing, experimenting, and idea networking (Fu, 2019). A learning process in higher education encourages students to produce innovative products (Avcı & Durak, 2023; Watted & Barak, 2018). Differences in knowledge and understanding of one field of study can also affect the creation of innovative ideas.

Innovative ideas begin with a question arising from a learning problem. During the presentation of the problem at the beginning of learning, many students immediately responded about the direction or purpose of learning and asked the scope of innovations that could be implemented for integrated learning in elementary schools. Questions are among the highest forms of cognitive competence (Ramadhani et al., 2019; Wullschleger et al., 2023). Implementing lectures on the Development of Integrated Teaching Materials in Basic Education also emphasizes experience-based learning, namely experiencing the process of solving real problems in elementary schools. Where students who have been teachers can implement their knowledge to overcome problems faced in integrated learning (Robina-Ramírez & Medina-Merodio, 2019). Creative ideas also arise through student involvement in group learning with members from different socio-cultural backgrounds (Capron Puozzo & Audrin, 2021; Zehui et al., 2019).

Every individual has a different and unique way of thinking because of creative and innovative abilities. Communication will run smoothly with cooperation. These skills can be used simultaneously to increase student commitment and active participation in the learning process. Both of these skills can also result in improved academic achievement. When given a problem, students have been directed to achieve a specific goal, namely developing integrated teaching materials following the issues found in elementary schools. In line with study state orientation to learning objectives and performance approach are indirect antecedent variables, while extrinsic motivation is a direct antecedent variable for creative thinking disposition and innovative thinking skills (Avcı & Durak, 2023b). Involvement in solving problems is influenced by curiosity, innovation, and a focus on opportunities. There is no relationship between academic achievement and the disposition of creative thinking and innovative thinking skills. Limited improvisation has a slightly smaller impact, but different types positively impact creative and imaginative abilities. Unlimited improvisation encourages creative and innovative skills but can hinder them (Dou et al., 2021; Ismaeel, 2020).

Based on the five aspects of innovative thinking skills, the highest aspect is teamwork. A team consists of several individuals with different social and cultural backgrounds. As the learning model of this project, a learning grouping is carried out between students who are experts or have more extended experience in teaching but are less proficient in the use of technology in learning with students who have not long had experience or even have never taught at all but are skilled in the use of technology. The variety of academic abilities and disciplines possessed by team members is a factor that positively influences the innovation of projects carried out (Mu'minah & Suryaningsih, 2020; Usher & Barak, 2020). A study explains that the most critical factor in individuals that can affect the level of innovative thinking or power is the belief in the importance of mastering and applying constructivist learning (Kinay & Suer, 2020). Collaboration with various parties has been proven to open wider learning opportunities and develop innovative power (Albers et al., 2021; Miri Barak & Yuan, 2021; Erol & Klug, 2020).

Project-based learning with an expert-beginner model in pairs also involves parties in elementary schools, namely teachers and students, while exploring factual problems related to integrated education. In addition, students also apply experts to provide suggestions for improvements to the products developed from the project. Building cooperation with individuals from different backgrounds who still have expertise in the problem field pursued in completing a task can undoubtedly increase the exchange of ideas and information to broaden horizons and create new ideas (Homan et al., 2020; Saptenno et al., 2019). During the progress of project completion, lecturers monitor and evaluate to ensure progress and provide feedback. During the monitoring and evaluation process, it was very apparent how to involve each other in improving and completing parts of teaching materials during the preparation process. For example, the aspects of learning strategies suitable for training one of the 21st-century skills are enhanced and perfected by students with more teaching experience. The collaboration is in line with research conducted state that teams within projects can contribute and learn from each other (M Barak et al., 2020; Usher & Barak, 2020; Wullschleger et al., 2023). As students have done, results obtained through individual or member observations within the project team during field testing of designed products are discussed in an informal collaborative environment with elementary school teachers to improve the quality of previous designs.

The last indicator is the thinking system. At the time of project completion, lecturers determine the time used for monitoring and evaluation activities. When students are asked to convey the progress of completing the project, each team can evaluate the weaknesses or problems found in the team. One of them in group 1 said that tasks and responsibilities must be evenly distributed (So et al., 2019; Sun et al., 2023). Each member needs to communicate the difficulties experienced so that group members can immediately provide responses and actions that need to be taken. The condition follows previous research conducted state that working relationships between team members can be built through communication. The competence of each individual with different backgrounds can enrich ideas to produce creative problem-solving (Goyal et al., 2022; Stolaki et al., 2023).

4. CONCLUSION

Project-based learning with expert and beginner models in pairs significantly influences the students' innovative thinking skills. The ability to think innovatively students is developed through several stages in designing products, namely determining the focus of the problem to be solved, considering the needs of students in integrated learning, creating products by prioritizing the principles of integrated education, utilizing technology relevant to learning so that learning products are more exciting and practicing 21st-century learning skills in the teaching materials developed. This research contributes to the development of science, especially in developing innovative thinking skills. These skills can be

improved through project-based collaborative learning because the contextualized learning environment and diverse individual skills can encourage the growth of a variety of creative and innovative ideas. The focus of this research is still emphasized on the project produced in the group design although the perception of innovative thinking skills has been explored individually through questionnaires. In the next research, it is necessary to develop an authentic assessment that can measure innovative thinking skills in each individual.

5. ACKNOWLEDGE

This research was carried out with funding support from the Decentralization of the Graduate School of Universitas Negeri Malang with Number 5.4.13/UN32.14/LT/2023.

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