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Implementation of Project Based Learning (PjBL) Model with Differentiation Approach to Improve Critical Thinking Ability

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ABSTRACT

Objective: This study aims to determine the improvement of students' critical thinking skills on solar system material in the project-based learning (PjBL) learning model with a differentiated approach. According to PISA, the results of observations in class VII State JHS 13 Madiun and interviews with several science teachers, Indonesian students' science skills are in a low category. Therefore, an appropriate learning model is needed to facilitate students to improve their critical thinking skills. **Methode**: This research is classified as a type of quantitative research. The subjects in this study were 30 students of class VII A at State JHS 13 Madiun city and science teachers at JHS 13 Madiun city. **Results:** The analysis showed that this study's increase in pretest and posttest scores was high, with an N-gain value of 0.72. This study also shows that PjBL learning intensely impacts the critical thinking skills of junior high school students in solar system material with a d-effect size value of 0.79. **Novelty:** The novelty of this research is to collaborate the PjBL learning model with a differentiated approach. In this study, the syntax of PjBL learning collaborates with a differentiation approach that can facilitate all student characteristics. Project creation in this learning is done based on students' learning style characteristics.

INTRODUCTION

Natural Science is a branch of science in the form of principles, concepts, facts, and laws whose truth has been tested through the scientific process. Learning about knowledge in the form of facts, principles, and concepts, science learning also learns about the process of finding out about nature systematically. Science learning is learning that can provide sufficient space as a place to train the problem-solving process, develop scientific attitudes, and relate it to life in the real world. Science is one of the basic sciences that is important for the development of science and technology as a provision for facing the 21st century (Gamage et al., 2020; Icela, 2022; Khairani Astri et al., 2022; Novitra et al., 2021; Valladares, 2021). Skills in learning and innovating in 21st-century science learning have goals with 4C characteristics, namely critical thinking and problem-solving, collaboration, creativity, and communication (Arifin, 2017). Cahyono (2017) states that critical thinking skills are essential for successful learning, working, and living during the 21st century.

Critical thinking skills are one of the essential goals of education. One of the skills expected to be output in the ongoing learning process is critical thinking skills (Kemendikbud, 2016). Maulana (2017) argues that there are four reasons for the need for critical thinking skills, namely (a) The demands of the times require that each individual be able to search, select, and use information for their lives, (b) Everyone is constantly faced with various problems and choices so that everyone is required to be able to think critically in looking at various problems faced, (c) Critical thinking is an aspect that can help in solving problems so that each individual can compete pretty and

reasonably and be able to create pleasing cooperation with other individuals. Critical thinking ability is a form of rational (reasonable) and reflective thinking in order to make a decision that can ultimately be believed and the decision will be implemented. Critical thinking involves the value of arguments, credibility, identifying and drawing conclusions.

Critical thinking ability is one of the high-level thinking skills to find problems and the right ideas to solve a problem according to what is believed (Hamdani et al.., 2019). High-level thinking skills can be measured by the cognitive dimensions of the categories of analyzing (C4), evaluating (C5), and creating (C6) (Anggraini et al., 2019; Ichsan & Rahmayanti, 2020; Mahendra et al., 2020; Sudarmin et al., 2020; Rozi et al., 2021; Sole & Anggraeni, 2020; Suprapto et al., 2020). Critical thinking indicators consist of six aspects: interpretation, analysis, evaluation, conclusion, explanation, and self-regulation (Facione, 2015). In science learning, students' critical thinking skills are needed to solve problems found in experimenting. Critical thinking skills need to be integrated into learning as a learning goal because it can provide experience to compete in the future (Rachmawati & Rohaeti, 2018).

Purnamasari et al. (2017) stated that the critical thinking skills of Indonesian students still need to improve. This is reinforced by the results of the Programme for International Student Assessment (PISA) in 2018, showing that the ability of Indonesian students, especially in the field of science, is still relatively low, ranking 71 out of a total of 79 PISA participating countries (OECD, 2019). Meanwhile, the achievement of Indonesian students, especially in the field of science, according to the Trend in International Mathematics and Science Study (TIMSS), still needs to improve, with a score of 397 points and ranks 45 out of a total of 48 countries participating. Wasis et al. (2020) stated that only 3.00% of Indonesian students who were respondents to the TIMSS study reached a high level. This is in line with the results of observations made by researchers of seventh-grade students in one of the Madiun City State Junior High Schools and interviews with science teachers; the critical thinking skills of seventh-grade students are still relatively low. This is evidenced by the lack of active students during learning; student learning outcomes in the previous material still need to improve, and in learning activities, many students are less active during discussion and group activities. When in groups, many students still need to contribute to their groups, and some of them waste much time telling stories. As an educator, a teacher must be able to create learning that can train students' critical thinking skills to find learning information independently and actively create cognitive structures in students (Annansingh, 2019; Darmaji et al., 2019; Gunawan et al., 2020; Hursen, 2021; Lee, 2020; Setiadi & Elmawati, 2019; Wayan Santyasa et al., 2021).

The independent curriculum was designed by Minister of Education and Culture Nadiem Makarim to change and understand the perspective of education in Indonesia. In the independent curriculum, learning must be student-centered. One of the student-centred learning models is the Project Best Learning (PjBL) learning model. PjBL can be defined as learning with long-term activities involving students designing, making, and displaying products to solve real-world problems. PjBL learning can be used as a learning model to develop students' ability to plan, communicate, solve problems, and make the right decisions from the problems faced. PjBL is a learning model that uses projects or activities as its goal. PjBL can improve critical thinking skills through activities to seek information from many sources. Furthermore, PjBL helps understand the subject more deeply and consider different views and also encourages students to

engage in an active investigation, explore a problem from various perspectives, learn how to ask related problems, gather information, solve problems, and be responsible for the results of their presentation (Guo et al., 2021; Haniah et al., 2021; Hussein, 2021; Kartini et al., 2021; Markula & Aksela, 2022; Parker, 2020; Pranjol et al., 2022).

There are six distinctive characteristics of PjBL: making basic questions, focusing on learning objectives, actively participating in learning activities, collaborating with students, using technology, and creating actual artifacts (Guo et al., 2020). According to Yulianto (2017), the PJBL learning model has steps that distinguish it from other learning models, namely: 1) determining fundamental questions related to the material, 2) designing projects, 3) planning project schedules, 4) monitoring project progress, 5) project assessment, 6) evaluating project experience. This PjBL learning model is 1) to provide students with broad insights to deal with the problems faced and 2) to develop critical thinking skills.

To improve students' critical thinking skills, teachers must be able to differentiate classroom learning instructions. Each student has different characteristics. Teachers need to understand the characteristics of students so that they can easily manage everything related to learning, including the selection of strategies for organizing teaching (Estari, 2020). One of the learning strategies that can fulfill the learning needs of students who have diverse abilities is differentiated learning. Differentiated learning is one of the learning strategies orientated towards students' learning needs (Naibaho, 2023). Faiz et al. (2022) stated that differentiated learning is learning that teachers make to meet the learning needs of students in the classroom, which includes learning readiness, interest, and learning profile. The characteristics of differentiated learning, according to Maryam (2021), are as follows: 1) the learning environment contains students to learn; 2) the curriculum has clearly defined learning objectives; 3) there is continuous assessment; 4) teachers respond to student learning needs, 4) effective classroom management. Differentiated learning includes 1) content differentiation, 2) process differentiation, and 3) product differentiation (Marlina, 2020).

The PjBL learning model can help students to make more meaning of their knowledge so that their critical thinking skills increase. This aligns with research conducted by Sularmi et al. (2018), which states that PjBL learning significantly improves students' critical thinking skills. This happens because students experience an increased role (active) in the learning process. Therefore, to help students improve their critical thinking skills, applying a suitable learning model, likely PjBL, is necessary. One of the science materials for class VII this semester is the solar system. In solar system material, students' critical thinking skills are needed to achieve learning objectives. Research to improve critical thinking skills with the PjBL learning model with a differentiated approach to solar system material needs to begin based on observations and literature reviews conducted by researchers. This makes this research urgent to do. The novelty of this research is to collaborate the PjBL learning model with a differentiated approach. In this study, PjBL learning syntax is collaborated with a differentiated approach that can facilitate all student characteristics.

RESEARCH METHOD

The type of research used is quantitative research, which aims to determine how much influence the learning model has in improving students' critical thinking skills. The subjects in this study were 30 students of class VII-A State JHS 13 Madiun City. Sampling was done by purposive sampling technique. The data collection technique

was carried out in 3 stages, namely: (1) planning, (2) implementation, and (3) data processing. In this study, the data analysis techniques used were n-gain and d-effect. There are two instruments used in this study, namely: (1) measurement instruments in the form of pretest and posttest questions to measure critical thinking skills, and (2) Treatment instruments in the form of teaching modules, evaluation questions, and student worksheets.

RESULTS AND DISCUSSION

Results

Descriptive statistical calculations can be made based on the pretest and posttest scores, as seen in Table 1.

Table 1. The statistic is descriptive.

Statistics	Pretest	Posttest
N	30.00	30.00
Mean	48.27	85.00
Std. Deviation	13.71	8.45
Skewness	0.54	0.33
Minimum	30.00	70.00
Maximum	80.00	100.00

To determine the normality of the pretest and posttest data, it can be seen from the skewness value in Table 2. Based on Table 2, it can be seen that the pretest skewness value is 0.11, and the posttest skewness value is 0.38. Because this value is in the range of -1 to +1, this study's pretest and posttest data are typically distributed. Normally distributed research data will be tested for statistical differences with the paired sample t-test using SPSS 20.0 for Windows. The results of the paired sample t-test can be seen in Table 2.

Table 2. Results of paired samples t-test.

Statistic Descriptive	Std. Deviation	count	table	Df
Posttest-Pretest	11.2	17.65	2.04	29

From Table 2, it can be seen that the tcount value (13.91) > t table (2.04) at the significance level α = 0.05. Based on this data, it can be concluded that the pretest and posttest scores in this study have significant differences. The N-gain formula can measure the increase in critical thinking skills. After knowing the magnitude of the increase, the calculation of d-effect size is carried out to determine the impact of the PjBL model on the increase in pretest scores to students' posttest scores. The results of the N-gain and d-effect size data analysis can be seen in Table 3.

Table 3. Results of d-effect size and N-gain data analysis.

Statistic Descriptive	Result
N-gain	0.72
d-effect size	0.79

Based on the data in Table 3, it can be seen that the N-gain value in this study is 0.72. If the n-gain value ≥ 0.70, the value is included in the high category (Dewantara et al., 2020; Lengkana et al., 2023; Muslimin & Abidin, 2023; Rasma et al., 2020; Salikha et al.,

2021). This means the increase in students' critical thinking skills is in the high category after PjBL learning. In Table 3, it can also be seen that the d-effect size value in this study is 3.57. If the d-effect size value is between 0.60 and 0.80, the value is in the strong category. It can be concluded that PjBL learning has a substantial impact on improving students' critical thinking skills on solar system material.

Discussion

The study results show that the PjBL learning model combined with a differentiated approach has a good effect on students' critical thinking skills. This is evidenced by the N-gain value of 0.72. If the n-gain value ≥ 0.70, then the value is included in the high category, which means that the increase in students' critical thinking skills is included in the high category after PjBL learning. This study also shows that PjBL learning strongly influences the critical thinking skills of junior high school students on solar system material, with a d-effect size value of 0.79. If the d-effect size value is between 0.60 and 0.79, the value is included in the strong category. This is relevant to research conducted by Sularmi et al. (2018), which states that the PjBL learning model has a significant effect in improving students' critical thinking skills, and research conducted by Yanti (2017), which states that the PjBL can improve students' critical thinking skills. This happens because students experience an increased role (active) in the learning process through the steps of the project-based learning model combined with the differentiation approach.

PjBL, with a differentiation approach, begins with ice-breaking preliminary activities that have been carried out well. Stage 1, namely asking essential or fundamental apperception questions, the teacher asks apperception questions about the solar system that have been adapted to the reality of students' lives. Then, proceed with the delivery of learning objectives. This is by what was conveyed by Putri & Qosyim (2021), that in the introductory activities, motivation in the form of apperception must be given to students, as well as providing information about learning objectives so that students are excited and know the direction of learning. Stage 2, namely designing tasks/projects that students will make, the design is carried out collaboratively between teachers and students. The teacher divides groups in this activity based on students' learning styles. Grouping students aims so that students can work together in the learning process. According to Alhafiz (2019), group formation in differentiated learning tends to be flexible. Students with advantages in specific fields will join and work with other friends. Furthermore, stage 3 is compiling the steps of making the project. At this stage, students make a schedule to complete the project and determine the final time of project completion. The schedule that has been made is then agreed upon so that the teacher can monitor the project's progress.

At this stage, the teacher monitors the student's activities during the project. To make monitoring easier, teachers create rubrics that can monitor all activities. Stage 5 is assessing student work; this assessment is carried out to help teachers measure student achievement. The results of this assessment can help the teacher develop the next learning strategy. Stage 6 is evaluating the experience gained by students. At this stage, teachers and students reflect on the learning activities that have been carried out. At this stage, students are asked to express their feelings and experiences while completing the project. Teachers and students then hold discussions to improve performance during the learning process. So, a new finding is found to answer the problem posed at the initial stage of learning.

PjBL collaborated with a differentiated approach in this research by considering students' learning styles. Learning style is a way that students can quickly receive information while learning. There are three categories of learning styles: visual, auditory, and kinesthetic. In this study, students with auditory learning styles did projects in the form of videos, students with visual learning styles did projects in the form of posters, and students with kinesthetic learning styles did projects visualizing the movement of the earth's rotation and revolution. The results of this study state that PjBL learning with a differentiated approach can improve the critical thinking skills of junior high school students on solar system material. PjBL learning can improve students' critical thinking skills because PjBL learning focuses on the main concepts and principles of a discipline, involves students in problem-solving and other meaningful tasks, gives students opportunities to work autonomously to construct their learning, and culminates in producing valuable student work products.

In addition, the increase in students' critical thinking is supported by learning that is packaged with a differentiated approach that pays attention to students' learning styles so that all students can be facilitated according to student characteristics and can improve students' critical thinking skills with differentiated learning is better than students who get ordinary learning. This is relevant to the research of Wahyuni et al. (2023), which states that the project-based learning model combined with differentiated strategies and paying attention to students' learning styles can increasingly maximize students' creative thinking skills.

CONCLUSION

Fundamental Finding: Based on the analysis and discussion that has been described, it can be concluded that learning with the Project Based Learning model can improve the critical thinking skills of students in class VII A State JHS 13 Madiun on solar system material with an average N-again value of 0.72 (high) and d-effect of 0.79 (strong). **Implication:** This research can be used as a reference for science teachers in implementing learning on solar system material to improve students' critical thinking skills. **Limitation:** This research only implements a PjBL model with a differentiation approach to improve critical thinking skills on solar system material. **Future Research**: Using the PjBL model with a differentiation approach will be developed to train critical thinking skills in solar system science learning and other subjects and materials.

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