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Problem-Based Learning Through Authentic Assessment: Students' Cognitive and Creative Thinking Abilities

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Annotation. Researchers apply the use of a PBL model integrated with authentic assessment. With the aim of knowing the effect of integrated PBL authentic assessment. The research method is experimental research. The sample was students from Senior High School. The data collection instrument is test questions. Descriptive statistical data analysis. The research results revealed that the integrated PBL model of authentic assessment had a significant effect on students' cognitive and creative thinking.

Keywords: *Problem-Based Learning (PBL), authentic assessment, students' cognitive and creative thinking.*

Introduction

The problem in the field so far is that the learning model that is often used is direct instruction, where the learning model takes place in one direction, namely the teacher

as the lecturer and the students as listeners. This causes the learning to be quite boring and cannot empower all students' abilities, such as cognitive abilities or students' creative thinking. Prayekti (2006) revealed that science learning in Indonesia still emphasizes the level of memorization of various materials or subjects without being followed by an understanding that students can apply when faced with real situations in their lives. Student activities can be said to be just listening to the teacher's explanation and noting things that are considered important. From these findings, aspects of the context of science application prove that many students in Indonesia are unable to connect the scientific knowledge they learn with natural phenomena, because they do not have the experience to make the connection (Firman, 2007).

Problem-based learning provides opportunities for students to learn broader things and focus on preparing students to become active and responsible citizens. Through PBL, students gain experience in dealing with realistic problems and emphasize the use of communication, cooperation, and existing resources to formulate ideas and develop reasoning skills, in which students learn by inspiration, group thinking, and using related information. To try to solve both real and hypothetical problems, students are trained to synthesize knowledge and skills before they apply them to the problem (Kuan-nien et al., 2011). PBL encourages students to be active in discussion activities and solve problems given (Asyari et al., 2016).

PBL as a product of constructivist learning theory requires students' active role in understanding knowledge and developing their reasoning. Students are also thinking critically based on problems and applying them in their daily lives. Here we see that PBL tries to give meaning to the knowledge and learning experienced by students. In the evaluation program, PBL can be assessed as orientated towards the process and the results obtained (Esema, 2012). The research results of Hidayati et al. (2019) reveal that the problem-based learning (PBL) model and integrated problem based learning and digital mind map (PBL-DMM) have an effect on student creativity. Research by Amanda et al. (2022) reveals that there is a significant relationship between critical thinking skills and mastery of concepts and problem-solving skills after implementing the CS-PBL learning model. In this research, PBL was integrated with authentic assessment in solving problems in biotechnology learning for class XII high school (SMA) students.

Assessment in learning is an inseparable part of the educational process. Efforts to improve the quality of education can be achieved through improving the quality of the learning and assessment system. A good assessment system will encourage teachers to determine the right strategies for learning and motivate students to learn better. However, the reality in schools, both in international and national contexts, is that assessment is still not functioning well, especially at SMA Nusantara Indah Sintang. Apart from that, initial survey data also found that assessments so far tend to take the form of tests and non-tests which are part of the final learning assessment, while assessments during the learning process are rarely carried out.

Black and William (2006) and Budiyono (2010) revealed that assessment so far has been done by making grades at the end of the material, resulting in subjectivity that is biased and unfavorable for improving the quality of learning, such as encouraging rote and superficial learning; assessment is seen more as a competition; not paying attention to students' learning difficulties; and separating assessment in the learning process.

Meanwhile, according to Mueller (2008), authentic assessment is "a form of assessment in which students are asked to perform real-world tasks that demonstrate meaningful application of essential knowledge and skills", Authentic tasks are tasks that are actually assigned to students to measure the achievement of the competencies being learnt, either when the learning activity is still ongoing or when it has ended, such as writing a scientific paper or work report. Meanwhile, according to Nurgiyantoro (2011), authentic assessment emphasizes students' ability to demonstrate their knowledge in a real and meaningful way, do not simply ask or tap knowledge that students already know, but rather perform the skills mastered.

According to Frey et al. (2012) authentic assessment, can support classroom instruction, collect evidence from multiple activities, produce learning and teaching between participants, reflect local values, standards and control. Palm (2008) also concluded that authenticity is defined as an assessment that is real in the sense of the process and product of the assessment conditions or context, and is true for life outside of school, curriculum, and classroom practice or learning and instruction. Assessment is not only aimed at giving scores and making rankings, but also an effort to provide feedback to both students and educators to make improvements to teaching and learning as soon as possible to achieve common goals. In other words, assessment has always been an integral and inseparable part of learning and a crucial part of helping students and educators in teaching and learning (Purnomo, 2013).

According to Rodriguez and Gallardo (2017), an authentic task can be in the form of students being asked to write a plan following a predetermined structure and recording a video presentation using the plan as a script. The plan should be placed in the student's workplace or daily activity environment and refer to real technology-related learning issues that are of concern while the student is taking the course. Given the nature of the assignment, the framework of sub-competencies must be clear in the final product, as students must demonstrate creating material, supporting learning decisions based on literature, integrating multicultural features, formulating strategies, and discussing information. In this research, researchers looked at the effect of using an integrated PBL model of authentic assessment on the dependent variable, which included students' cognitive and creative thinking on biotechnology material.

Problem-based learning is meant in this learning is that learning is still carried out using PBL stages, but in solving problems, students work through authentic tasks given, namely making learning journals, making reports, group presentations, making products. Apart from that, student performance is observed using observation sheets.

From authentic assignments carried out, students can learn from various learning sources, including using technology and the Internet. So that in this way the problems posed can be resolved/search for causes and solutions, so that the concepts studied can be understood and especially can empower students' cognitive and creative thinking abilities. The following is a PBL syntax that integrates authentic assessment.

Table 1

PBL Syntax for Integrated Authentic Assessment (Modification, Arends 2008)

Stage	Syntax	Teacher and Student Activities	Time
I	**Initial activity**		
	Stage 1 Student orientation to the problem	The teacher explains the learning objectives, explains the logistics required, motivates students to be involved in the problem-solving activities they choose.	5'
II	**Core learning activities**		
	Stage 2 Organizing students to learn	- The teacher helps students define and organize learning tasks related to the problem. -Providing authentic assignments (group presentations, making products, daily journals).	10'
	Stage 3 Guiding individual and group investigations	- Teachers encourage students to collect appropriate information, to carry out experiments, to obtain explanations, and to solve problems. - Teachers guide students to solve problems through authentic tasks given.	60'
	Stage 4 Develop and present work results	- Teachers help students in planning and preparing appropriate work, such as reports, videos, and models, and help them share assignments with their friends. - Students present authentic assignments they have completed.	20'
III	**Closing learning activities**		
	Stage 5 Analyze and evaluate the problem solving process	- Teachers help students to reflect on and evaluate investigations and the processes they use. - Students collect work products.	15'

Cognitive learning outcomes are results obtained by students in the form of knowledge or science that they have mastered within a certain period of time. Based on this description, it can be concluded that learning outcomes are abilities that students have as a result of learning activities expressed in the form of symbols, numbers, letters, and sentences that can reflect the results that have been achieved by each student. The cognitive domain, according to Bloom, is concerned with learning outcomes which

consist of six aspects, namely: knowledge (C1), understanding (C2), application (C3), analysis (C4), evaluation (C5), and creating (C6) (Duda et al., 2018). According to Ichsan et al. (2020), one of the reasons why students are still low in cognitive and reasoning is that teachers often do not implement Higher Order Thinking Skills (HOTS) based learning while implementing learning and still prioritize material based on Lower Order Thinking Skills (LOTS). HOTS and LOTS are aspects included in the cognitive process. LOTS is a student's ability in terms of lower knowledge aspects, while HOTS is a student's ability that requires analytical, critical and creative powers. Lecture learning is usually only concerned with LOTS and less concerned with HOTS.

Creativity is the skill of discovering new things that have not existed before, being original, developing various new solutions for every problem, and it involves the ability to produce new, varied, and unique ideas (Leen, 2014; Febrianingsih, 2022; Listiani, 2020; Hu & Adey, 2010). The ability to think creatively is something that is important for students, especially in the teaching and learning process (Listiani, 2020). Through creative thinking skills, students understand, master, and solve the problems they are facing. put forward creative new ideas or solutions in analyzing and solving the problem so that the right solution to the problem can be obtained. However, students' ways of expressing new ideas or solutions are, of course, different (Febrianingsih, 2022). Therefore, students' creative thinking abilities at school need to be analyzed so that this becomes the basis for providing solutions through the learning process or more appropriate use of learning resources.

Treffinger (Starko, 2010) believes that the importance of creative assessment is as follows: 1) helping students realize their strengths; 2) developing students' understanding of human abilities, especially the relationship between creativity and traditional views about intelligence; 3) can be used as an entry point or base-line for teachers in developing further learning processes; 4) evaluating teacher performance during the learning process; 5) understanding the various hidden potentials of student creativity; 6) eliminating the notion that creativity is a mystery that is difficult to develop.

From the background, it was explained that the general research objectives are that the application of problem-based learning models and authentic assessments can empower and improve students' abilities, especially cognitive abilities and creative thinking abilities. To facilitate the solution of the research problem, it can be formulated into several research questions, namely: first, how does the use of the PBL model integrated with authentic assessment affect students' cognitive and creative thinking? Second, how are the results for each cognitive indicator and each creative thinking indicator of students in the application of the PBL model integrated with authentic assessment? Third, is there a difference in the pre-test and post-test on cognitive and creative thinking after the application of the PBL model integrated with authentic assessment? With detailed research objectives, namely, first, to determine the effect of the use of the PBL model integrated with authentic assessment on students' cognitive

and creative thinking. Second, to determine the results on each cognitive indicator and each creative thinking indicator of students after the application of the PBL model integrated with authentic assessment. Third, to determine the difference in the pre-test and post-test on students' cognitive and creative thinking after the application of the PBL model integrated with authentic assessment.

Methodology

Research Methods

This research uses a quantitative approach with descriptive and experimental research methodology in the form of pre-experimental (classic experiment). The study aims to assess the effect of using problem-based learning models integrated with authentic assessments on students' cognitive and creative thinking. Where in the learning, the problems presented by the teacher in learning can be solved or solutions can be sought through authentic tasks given. The research design was one group pre-test–post-test. The independent variable consists of 1 level, namely the integrated PBL model of authentic assessment, which is divided into pre-test and post-test groups. Where the authentic assessments used to support the implementation of the learning model are in the form of authentic tasks such as group presentations, making products, working on daily journals. However, authentic assignment scores were not used to assess learning achievement in this research. Authentic assessment helps learning instructions run well and hone students' potential. Learning achievement can be measured in the form of tests that have been prepared. The dependent variable is cognitive and creative thinking. There are 2 control variables, namely manually and statistically. In addition to seeing the influence of the use of the model, researchers also describe the average value of each cognitive indicator as well as the average value of each creative thinking indicator. So that it can determine the highest and lowest average indicator values, this is good for both student cognitive and student creative thinking.

Table 2

One Group Pre-test–Pos-test Design (Cohen, 2011)

Pre-test	Treatment	Pos-test
O_1	X	O_2

Notes. O_1 : Pre-test (cognitive and creative thinking)
X Treatment: PBL terintegrasi asesmen autentik
O_2 Post-test (cognitive and creative thinking)

Population and Sample

The research population was Nusantara Indah Sintang Senior High School students. and the sample chosen in this research was even semester science students who were studying Biotechnology material. The sample size was determined using purposive sampling, which was in accordance with the researcher's needs by considering the characteristics of the learning model. The sample chosen was 1 class, where in one class there were 25 people, so the total sample was 25 students. Students' ages range from 17 to18 years. The duration of the research is around 4 weeks. The number of samples is limited because it is adjusted to the actual number of students in the class; this may be a limitation of the study.

Data Collection Techniques and Tools

The data collection techniques used are measurement techniques and direct observation techniques. The data collection tools are 30 cognitive test questions and 30 creative thinking test questions, as well as observation sheets during learning. Before the research instrument is used, a validation test is first carried out by a team of experts and followed by a trial of test questions which includes a validity test, reliability test, difficulty level test, and discrimination test. The questions were tested using the Anates software program, where from 40 cognitive questions tested, 30 cognitive questions are said to be worthy with a high category. And also, from 40 creative thinking questions tested, 30 creative thinking questions are said to be worthy with a high category. Questions are said to be feasible because they meet the requirements for validity ($r_{xy} \geq r_{table}$), reliability ($r_{11} > r\text{-}_{table}$), distinguishability ($D \geq 20$), and level of difficulty ($P \geq 20$).

Research Procedure

The procedure in this research consists of several stages, namely: 1) preparation stage, 2) implementation stage, and 3) final stage.

1. *Preparatory stage*

The steps taken in the preparation stage include: 1) conducting observations at Nusantara Indah Senior High School; 2) creating research instruments in the form of: test questions to measure cognitive and test questions to measure students' creative thinking abilities; 3) validating the instruments research; and 4) determining the time for carrying out the research, namely consulting with the biology teacher at Nusantara Indah Senior High School.

2. *Implementation stage*

The steps taken at the implementation stage include: 1) providing an explanation to students about the purpose of the activities to be carried out and instructions for their implementation; 2) providing a pre-test before learning, which includes cognitive

and creative tests for students; 3) carrying out learning in class experiment using an integrated PBL model of authentic assessment; 4) providing a post-test after learning, which includes cognitive tests and students' creative thinking.

3. *Final stage*

The steps taken in the final stage include: 1) analyzing the data, which includes: descriptive and quantitative data; and 2) compiling a research report and writing a research article.

Data Analysis

This research data is data about students' pre-test and post-test cognitive and creative thinking. Multiple-choice test questions cover students' cognitive and creative thinking. The data analysis technique uses descriptive statistics. Descriptive statistical values include mean, standard deviation, highest mean, lowest mean, and increase from pre-test to post-test, apart from that, the dependent variable score data is displayed in graphical form. Hypothesis testing can be carried out using the Paired Samples t-test if the data after normality and homogeneity testing has a normal and homogeneous distribution. Paired Samples t-test is used to test results where the participants are the same but the variables are taken under different circumstances. The criteria for making the decision to test the hypothesis are if the t-count value is greater than the t-table, then Ha is accepted and Ho is rejected, indicating that there is a significant influence on the treatment given, whereas if t-count is smaller than the t-table then Ha is rejected and Ho is accepted, then it shows that there is no significant influence on the treatment given. Statistical calculations used the SPSS version 21 program with a significance level of 0.05 ($p < 0.05$).

Results

Based on the results of data analysis, research results can be obtained from the application of the PBL model integrated of authentic assessment to the dependent variable studied. Below are presented the average values for the two dependent variables, namely students' cognitive and creative thinking.

Table 3

Average Scores for the Two Dependent Variables

Student value	Cognitive value		Creative thinking value	
	Pre-test	Pos-test	Pre-test	Pos-test
Highest value	79	95	78	90
Lowest value	26	75	25	70
Average value	40.83	83.83	41.5	82.25

From the data in Table 3, average cognitive pre-test score (40.83) is lower than the cognitive post-test score. Likewise, in the creative thinking data, the pre-test score (41.5) was lower than the creative thinking post-test (82.25). The post-test score on cognitive and creative thinking is higher than the pre-test score. After looking at the overall average data, proceed to look at the data for each dependent variable based on the indicators. Cognitive variables studied to determine students' mastery of concepts regarding the material being studied, namely biotechnology. The result students' cognitive from the six indicators can be seen in Table 4.

Table 4
Students' Scores From the Six Cognitive Indicators

Cognitive indicators	Cognitive value					
	Pre-test			Post-test		
	Lowest value	Highest value	Average value	Lowest value	Highest value	Average value
Knowledge (C1)	45	79	55	90	95	92
Understand (C2)	40	65	50	85	95	88
Apply (C3)	35	50	45	80	90	86
Analyze (C4)	30	40	35	80	85	83
Evaluate (C5)	28	35	32	75	80	78
Create (C6)	26	30	28	75	78	76

From the cognitive test results of the six cognitive indicators, it can be seen that the highest pre-test average score is for indicator C1 (55) and the lowest pre-test average score is for indicator (C6) (28). Likewise, the cognitive post-test data show that the highest average value is indicator C1 (92) and the lowest average post-test value is indicator C6 (76). From the data in Table 2, it can be seen that the higher the cognitive indicator, the lower the average cognitive value. This can be concluded that students find it increasingly difficult the higher the cognitive indicator, where students' mastery of concepts at a low cognitive level is higher than students' mastery of concepts at a high cognitive level.

Based on the results of the pre-test and post-test hypothesis calculations on student cognition, it is known that the t-count value is 2.55 while the t-table value is 1.714, so H_1 is accepted and H_0 is rejected, meaning that there is a significant difference in student cognition before and after learning about biotechnology material. Statistical calculations using the SPSS version 18 program with a significance level of 0.05 ($p < 0.05$) show p (2-tailed) = 0.000 < 0.05. For more details about the data, see Table 5.

Table 5

Hypothesis Test Results With t- test for Students' Cognitive Abilities

Treatment	N	Pre-test mean	Post-test mean	t-count value	t-table values	Notes
PBL is integrated with authentic assessment	25	40.83	83.83	2.55	1.714	There are significant differences

Apart from cognitive, what was also examined, was students' creative thinking abilities. Where the ability to think creatively is one of the high-level thinking abilities that students must have. The results of research on students' creative thinking abilities from the four indicators can be seen in Table 6.

Table 6

Students' Scores From the Four Creative Thinking Indicators

Cognitive indicators	Cognitive value					
	Pre-test			Post-test		
	Lowest value	Highest value	Average value	Lowest value	Highest value	Average value
Ability to think fluently (fluency)	45	78	55	85	90	88
Ability to think flexibly (flexibility)	40	55	40	80	90	85
Ability to think original (originality)	30	40	36	75	85	81
Ability to detail (elaboration)	25	40	30	70	80	75

From the data in Table 6, for the four creative thinking indicators, the highest pre-test average score is for the fluent thinking ability indicator (55), and the lowest pre-test average score is for the detailed ability indicator (30). Likewise, the cognitive post-test data shows that the highest average score is for the fluent thinking indicator (88) and the lowest average score is for the detailed ability indicator (75). From the data in Table 5, it is seen that the higher the indicator of creative thinking ability, the lower the average value of. These students find it increasingly difficult when asked to detail concepts or elaborations, and students master more the ability to think fluently followed by the ability to think flexibly and think originally.

Based on the results of the pre-test and post-test hypothesis calculations on students' creative thinking, it is known that the t-count value is 2.50 while the t-table value is 1.714, so H_1 is accepted and H_0 is rejected, meaning that there is a significant difference in students' creative thinking abilities before and after learning on biotechnology material. Statistical calculations using the SPSS version 18 program with

a significance level of 0.05 ($p < 0.05$) show p (2-tailed) =0.000 < 0.05. For more details about the data, see Table 7.

Table 7
Hypothesis Test Results With t-test for Students' Creative Thinking

Treatment	N	Pre-test mean	Post-test mean	t-count value	t-table values	Notes
PBL is integrated with authentic assessment	25	41.5	82.25	2.50	1.714	There are significant differences

From the data in Table 5 and the data in Table 7, there are significant differences in students' cognitive and creative thinking before and after learning. This is, of course, influenced by the problem-based learning model through authentic tasks carried out, such as making learning journals, making reports, group presentations, making products. Apart from that, student performance is observed using observation sheets, so that the problems posed can be resolved and can empower cognitive abilities. and students' creative thinking.

Discussion

PBL Integrates Authentic Assessments of Students' Cognitive and Creative Thinking

From the research results for the two dependent variables, namely cognitive and creative thinking, students show an improvement after PBL learning is integrated with authentic assessment compared to before learning. From these data, PBL integrated with authentic assessment has a very real effect on students' cognitive abilities and has a real effect on students' thinking abilities. This is supported by the overall statistical data that the t-count is greater than the t-table where in cognitive t-count = 2.55 and t-table = 1.714, in creative thinking t-count = 2.50 and t-table = 1.714. This is as expressed by Sudarman (2007), who states that the basis of PBL is a collaborative process. Learners will organize knowledge by building reasoning from all the knowledge they have and from everything they obtain as a result of interacting with fellow individuals. With PBL, it is hoped that students can solve problems with a variety of alternative solutions and can identify the causes of existing problems. In line with the opinion of Wahyuni (2011), who stated that the higher the relevance of the problem, the higher their desire to work to solve the problem. According to Walker and Heather (2009), in problem-based learning, the teacher acts as a facilitator and helps students in reminding students of theoretical knowledge that is relevant to the problems encountered, as well as leading students in identifying errors in their own understanding.

Wulandari (2011) revealed that PBL is designed by confronting learning with contextual problems related to learning material so that students know why they are learning, then identify problems and collect information from learning sources, then discuss it with friends in their group to get solutions to problems while achieving learning goals

Apart from that, Duda et al. (2019) research also shows that authentic assessment also has an influence on improving students' cognitive abilities. Various types of authentic assessments, including performance assessments, portfolio assessments, and self-assessments, can improve the quality of learning that is beneficial for students (Zahrok, 2009). Authentic assessment is an activity of assessing students that emphasizes what should be assessed in real terms, both process and results, with various assessment instruments that are adapted to existing competency demands (Kunandar, 2014). Project assessment is an assessment activity of assignments that must be completed by students according to a certain period. Completion of the assignment in question takes the form of an investigation of students, starting from planning, data collection, organizing, processing, analyzing, and presenting data. Thus, project assessment touches on aspects of understanding, applying, investigating, etc. (Majid, 2014).

Authentic assignments allow students to apply learning and make connections between school and the life they experience. The most prominent thing about authentic assessment is that the focus of the assessment is not just to test the knowledge that has been gained, but the assessment process becomes part of the learning process (Nisrokha, 2018). To be interpreted as an assessment that includes student learning processes and outcomes, so that with this assessment system, various assessment methods can be carried out and various aspects of students can also be assessed. In this way, the assessment results become more complete because all the students' efforts and abilities (including cognitive, affective, and psychomotor) can be revealed and can be appreciated with grades. The assessment results are very objective, so they reflect the condition of students individually and in groups (Zahrok, 2009).

Authentic assessment monitors and measures students' abilities in various possible solutions to problems faced in real-world situations or contexts. In a learning process, authentic assessment measures, monitors, and assesses all aspects of learning outcomes (covered in the cognitive, affective, and psychomotor domains), both those that appear as the final result of a learning process, as well as changes and developments in activities and learning gains during the learning process in the classroom and outside the classroom (Nisrokha, 2018).

Cognitive Thinking Ability

In this research, it was seen that after the integrated PBL model of authentic assessment, there was a cognitive increase for the six cognitive indicators from pre-test to post-test. With the results, the indicator that has the highest value is the cognitive indicator of C1(knowledge), and the lowest value is the indicator C6 (creating). From the

results of this research, students master low-level cognitive skills better than high-level cognitive ones. But overall, there was an improvement from before learning and after learning. According to Ibda (2015), in the results of his research on Piaget's theory, the level of human intellectual development influences maturity, physical experience, logical experience, social transmission, and self-regulation. Piaget's theory is clearly very relevant in the process of children's cognitive development, because by using this theory, humans can determine the existence of certain stages of development in children's thinking abilities at their level. Susana in Sutrisno (2019) states that students are said to have mastered a concept if the student has been able to carry out a series of processes called cognitive processes, including the ability to C1 (remember), C2 (understand), C3 apply (apply), C4 (analyse), C5 (evaluate), and C6 (create).

Another thing stated by Duda et al. (2018) is that students' cognitive learning outcomes are high; this is because students are actively involved in learning. Where in learning, a teacher should act as a facilitator. A teacher plays the role of controlling student activities in learning. Meanwhile, largely taken over by students. Students must be active in asking questions, answering questions, speaking, and so on.

Students' cognitive abilities are influenced by the learning atmosphere and the way teachers teach (Handayani et al., 2015). The learning atmosphere and the way teachers teach are influenced by the learning model used. An appropriate learning model that is appropriate to the characteristics of students and the material presented influences students' attractiveness in participating in the learning process.

Studying concepts in biological material, especially contextual material and the requirements for mechanisms or procedures, requires a level of thinking at the application and analysis level. Research results Putri et al. (2017) show that only a portion of students have application thinking skills (22.43%) and analysis (24.13%); therefore, this thinking process still needs to be trained and developed in students.

From the research data, it is seen that the low-level cognitive test questions, or low-order thinking skills (LOTS), which include C1–C3. have higher scores than the high-level cognitive test questions, or high-order thinking skills (HOTS), which include C4–C6. It can be said that the higher the cognitive level, the lower the student's scores will be. This is caused by several factors, namely students consider low-level test questions to have easier question quality compared to high-level cognitive test questions. Apart from that, field data also reveals that students' higher thinking abilities are rarely utilized, or the test questions made by teachers are low-level cognitive test questions.

This is supported by several other studies, namely Alfiatin and Oktiningrum (2019), which found that the high-level thinking abilities of fifth-grade students at Imam Bonjol Elementary School were in the sufficient category, with the average score obtained being 67.85. These results also show that students' abilities are still low in the cognitive domain C6 (creating). It cannot be denied that these results are a result of students' unfamiliarity with working on HOTS type questions. Students tend to be used to

learning and giving LOTS type questions. Considering that daily test questions, or grade promotion assessment questions, are still in the realm of C1 to C3 only (LOTS), there are C4 but not many as stated by the Principal during the observation activity. It is not only the giving of HOTS type questions that is in the spotlight, but also the way students organize or design how to answer questions, starting from making them known, asking questions to answering them. HOTS thinking ability is sufficient, and the low ability to answer C6 cognitive domain questions is also the result of a lack of practice in designing steps to solve problems in the questions. Students also acknowledged the obstacles in designing steps to solve these questions in the interview session.

Yuliati and Lestari (2018) also revealed that the absence of training activities and ability measurement has an impact on students' low abilities in the cognitive domains of analysis, evaluation, and creation. Students need to get used to measuring through HOTS; otherwise, it will cause the HOTS potential in students not to develop (Arifin & Retnawati, 2017). The cause of the obstacles experienced by these students is that learning activities are still based only on knowledge transformation, only stemming from the cognitive domains C1, C2, and C3, or LOTS, without criticizing and discovering activities in the C4 to C6 or HOTS domains. So, students have difficulty answering HOTS questions. Students tend to make mistakes in answering questions because the questions given are different from the procedures given by the teacher (Wilson, 2000).

In developing good HOTS-based items for students, teacher quality is a very important part in this case. Teachers must have a good understanding of cognitive processes in Low Order Thinking Skills (LOTS) and Higher Order Thinking Skills (HOTS). Teachers play a role in optimizing HOTS assessments, both in daily tests, end of semester assessments, and school exams. This is intended to train and identify the categories of students' high-level thinking abilities (Saraswati & Agustika, 2020).

Creative Thinking Ability

In this research, it was seen that after learning with the PBL model integrated with authentic assessment, there was an increase in students' creative thinking for the five indicators of students' creative thinking. Where the indicator with the highest value is the ability to think fluently and the indicator with the lowest value is elaborate. This is as stated by Khoiri et al. (2017) that improving creative thinking ability can be done by using learning methods implemented in the learning process. Coon and Mitterer (2014) stated that creative thinking or creativity is a problem-solving activity carried out through an unconscious experiential process which includes fluency in generating a number of ideas, flexibility, using time to produce various types of solutions, and the novelty of the ideas or solutions produced. Creative thinking abilities can be sharpened through active learning (Ernawati et al., 2023; Pujawan et al., 2022).

Diana (2018) states that creative thinking is a mental activity that a person experiences when facing a problem that must be solved and trying to create new ideas.

Creative thinking competency is a very important thing for students to have in the era of global competition, because the level of complexity of problems in all aspects of modern life is increasing (Mursidik et al., 2015).

According to Uno and Nurdin (2014), the driving factors for creativity are: a) Sensitivity in seeing the environment: students are aware that they are in a real place; b) Freedom in seeing the environment: being able to see problems from all directions; c) Strong commitment to progress and succeed: great desire to know; d) Optimistic and willing to take risks: likes challenging tasks; e) Perseverance to practice: broad insight; f) The environment is conducive, not rigid and authoritarian.

Research data reveals that each indicator has a different average value. Of course, this is caused by several factors, including depending on the students' abilities in that context. also supported by students' habits in working on creative thinking questions. If you rarely do creative thinking questions/rarely use you on certain indicators, this will of course result in lower scores. This is supported by research by Hanurrani (2019) that each person's creative thinking ability is different. differences in abilities are influenced by students' abilities. Will appear when someone faces a problem. From how to faced, a person's creative thinking ability can be seen. A form of problem that supports someone in solving it is an open-ended problem. Mufidah (2014) stated, "Students with low mathematics ability only meet the criteria for creative thinking fluency, so they are classified as fewer creative students."

Conclusion

Based on the results of this research, it can be concluded that there is a significant difference in students' cognitive thinking abilities and creative thinking abilities between before and after learning with the integrated PBL model of authentic assessment. There was an increase in the six students' cognitive indicators between before and after learning with the highest score on both the pre-test and post-test on the cognitive indicator remembering (C1) and the lowest on the creating indicator (C6). There was an increase in the four indicators of creative thinking ability between before and after learning, with the highest pre-test and post-test scores on the fluency thinking ability indicator and the lowest average score on the elaboration ability indicator. Test the hypothesis for both cognitive and creative thinking; the t-count value is greater than the t-table, so the difference between the pre-test and post-test on cognitive and creative thinking is significant Overall, it can be concluded that there is an influence of the integrated PBL model of authentic assessment on students' cognitive thinking and creative thinking abilities.

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Probleminis mokymasis taikant autentišką vertinimą: mokinių pažintiniai ir kūrybinio mąstymo gebėjimai

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Santrauka

Pastebima, kad iki šiol mokiniai vis dar aktyviai neįtraukiami į mokymosi procesą, todėl jie įsimena tik teoriją, jos giliai nesuvokdami bei kūrybiškai neįgalindami. Tyrimo tikslas – nustatyti integruoto probleminio mokymosi (angl. *PBL*) autentiško vertinimo poveikį mokinių kognityviniam ir kūrybiniam mąstymui. Taikomas tyrimo metodas – eksperimentas. Tyrime atliekamas vienos mokinių grupės testas prieš tyrimą ir testas po tyrimo. Tiriamiesiems atrinkti taikoma tikslinė atranka. Tyrime dalyvavo Nusantara Indah Sintango vidurinės mokyklos (Indonezija) XII klasės mokiniai. Kaip vertinimo priemonė buvo pateikiami testo klausimai. Buvo atlikta duomenų analizė taikant aprašomosios statistikos metodus. Tyrimo rezultatai atskleidė, kad rodiklis C1 (supratimas) turėjo didžiausią vidutinę reikšmę tiek prieš testą, tiek po testo, o rodiklis C6 (kūryba) – mažiausią. Didžiausia kūrybinio mąstymo rodiklio reikšmė yra gebėjimas sklandžiai mąstyti tiek prieš testą, tiek po testo, o mažiausias rodiklis – gebėjimas detalizuoti. Be to, kognityvinių hipotezių tikrinimo rezultatų p reikšmė <0,05 (0,000 <0,05). Tikrinant kūrybinio mąstymo hipotezę, p reikšmė <0,05 (0,000 <0,05), o tai rodo, kad yra statistiškai reikšmingų skirtumų prieš testą ir po testo. Iš to daroma išvada, kad integruotas autentiško vertinimo PBL modelis turi didelę įtaką mokinių kognityviniam ir kūrybiniam mąstymui.

Esminiai žodžiai: *probleminis mokymasis (angl. PBL), autentiškas vertinimas, mokinių kognityvinis ir kūrybinis mąstymas.*

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