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Junior High School Students' Problem Solving Skill: PBL-STEM Model Implementation

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Abstract: Problem solving skills (PSS) are one of the 21st century skills, but the problems encountered show that students' PSS in science learning are still low, using the PBL model with the STEM approach could be a solution to the students' problems. So, that the purpose of this study was to determine the effect of applying the PBL model with STEM approach to students' PSS. The method used in this research is quasi experimental method with one group pre-test-post-test design. The research population was students of class VIIA at a SMPN in Jombang. The instrument used was in the form of multiple choice questions with reference to PSS indicators, the data obtained is processed statistically and the results are analysed using n-gain calculations. Based on the results of the analysis, it can be concluded that the application of the PBL model with the STEM approach has an effect on the PSS of students in the moderate n-gain category, when viewed from the PSS indicator, the problem identification indicator gets the highest average of 94% followed by the indicator of setting goals, formulating solutions, and implementing solutions with an average of 72%, and result evaluation indicator with the lowest average of 66%.

Keywords: 21st Century Skill; PBL; Problem Solving Skill; STEM

Introduction

As we enter the 21st century with Industrial Revolution 4.0, high-quality human resources (HR) are required to compete in ASEAN countries, and education is an initiative for that purpose. Developments in the 21st century itself are marked by advances in technology, communication and information that are easily accessible to everyone. This development requires higher human capacity (Nurhasnah et al., 2022). 21st century skills come down to 3 skills, the first is thinking skills which consist of creative, innovative, critical, problem-solving, wise decision-making, learning; the second is way of working consisting of communication and teamwork skills; and the last is skills for living in the world that consists of being a global citizen, being aware of life and career development, and taking personal and social responsibility) (Quinn et al., 2012).

PISA which is an initiative initiated by countries that are members of the Organisation for Economic Cooperation and Development (OECD) is intended to assist countries in preparing their human resources to have competencies in line with the expectations of the international market, assessing several subjects, including basic literacy tests in reading, mathematics and science, regardless of curriculum national. The PISA assessment is expected to be able to assess the quality of education at a young age in schools to face the challenges of the 21st century, but according to the OECD there are as many as 21 countries that do not have a curriculum that focuses on future planning needed by the global industry (Pratiwi, 2019). According to the OECD 2018, Indonesia's PISA test results on science ability are still at the lower average level where Indonesia is in 64th position out of 76 countries (Andreas Schleicher, 2019). In the opinion of Pitaloka & Suyanto (2019), the low TIMSS and PISA scores are due to the TIMSS study and the PISA study using High Order Thinking Skills (HOTS) model questions which describe students' high level thinking abilities. These results indicate that high level thinking skills in Indonesia are still relatively low, including critical thinking skills and problem solving,

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Whereas the ability to think critically and solve problems as the skills needed in the 21st century in learning science.

Problem-solving ability is one of the skills expected of a country's human resources when dealing with problems in social life (Ratnaningdyah, 2017). Problem-solving ability is an important skill that we improve through different levels of education, junior high school students learn to think logically and critically and are very curious, so it comes down to how educators can develop their students' skills. The Merdeka Curriculum that is present in Indonesia is currently an answer to the intense competition for human resources globally in the 21st century (Marlina et al., 2022) which includes the ability to solve problems, in order to carry out learning, it is necessary to have a learning model that supports 21st century skills. According to Barus 2019, there are 7 learning models that teachers can choose to implement, including Discovery Learning; Inquiry Learning; Problem Based Learning (PBL); Project Based Learning (PjBL); Production Based Learning; Teaching Factory; and Blended Learning (Indarta et al., 2022).

PBL is a learning model that is very effective in shaping students' knowledge (Amalya et al., 2021), students will be more active during the learning process, so researchers say that the PBL model has a positive effect on students (Yana et al., 2022). One modern attempt to improve problem-solving skills is the use of PBL models with science, technology, engineering, and mathematics (STEM) approaches, The STEM approach is often widely used at the junior and senior high school levels (Khotimah et al., 2021). PBL presents contextual questions and makes learning more meaningful for students (Khairani & Aloysius, 2023; Iolanessa et al., 2020) STEM, on the other hand, is beneficial for students because it not only allows them to solve problems from a conceptual point of view, but also gives them a sense of what they are doing. Concepts can apply solutions. they make Aspect engineering in a STEM approach can train you to think about how to create tools that maximize their role in problem solving. Nuraziza & Suwarma, (2018) said that STEM education not only equips students with concepts but also answers the needs of Indonesian human resources.

STEM in education is a multidisciplinary approach that is expected to be able to build 21st century skills, the STEM approach is also able to improve HOTS in the process of problem solving and problem solving in students' daily lives (Zulirfan & Yennita, 2022). Research conducted by Adhelacahya et al. (2023), related to the use of the PBL model Electronic Module and the STEM approach can improve students' critical thinking skills, this research certainly supports the use of the PBL-STEM model related to students' problem solving abilities where students are also required to think critically.

Observations were made as a form of profiling students' needs in learning, in this case related to students' problem-solving abilities. The results of the observations showed that class VII students' problem-solving abilities were still low. The results of interviews with science teachers showed that students' abilities were still at the LOTS level, one of the reasons being the impact of the Covid 19 pandemic which made learning activities less effective. This is what affects students' 21st century skills which are still low, especially the problem solving abilities of students. Problem-solving skills can be developed and practiced through habituation of students in facing problems, one of them is habituation during the learning process in the classroom (Kurniawan et al., 2020).

Based on the facts that have been described, a solution is needed to answer the needs of students, one solution that can be done to overcome students' low problem-solving abilities is to use the PBL-STEM learning model as outlined in the form of student worksheet, so the purpose of this study is to describe students' problem-solving abilities after learning with the PBL-STEM model.

Method

This research is an experimental research, experimental research is a research method that can be categorized as a research method that is intended to look for the effects of giving certain treatments. The Quasi-experimental method was applied by designed one group pretest-posttest design (Table 1). First sample is provided pretest and at the end of the learning activities are given posttest (Sugiyono, 2010). This design is in accordance with the research objectives conducted by researchers, namely knowing the increase in students' problem-solving abilities after being treated in the form of a learning model Problem Based Learning (PBL) with a STEM approach.

In short, the flow of research conducted by researchers is as follows: (1) Observation of students to find out the needs of students, (2) Science teacher interview, (3) The implementation of pretest that related to students; problem solving abilities, (4) Provide treatment to students by implementing the PBL-STEM learning model, (5) Post-test implementation related to students' problem-solving abilities, (6) Analysis of data obtained.

The population of this study were class VII students for the 2022/2023 academic year at one of the Public Middle Schools in Jombang City. Class VII consists of 6 classes and samples selected using techniques purposive sampling, obtained class VII A as a sample with a total of 32 students.

Table 1. Research Design One Group Pretest-Posttest Design

Pretest	Treatmeant	Posttest
O_1	X	O_2

Explanation:
O_1: pre-test on the problem solving ability test
O_2: post-tests on the problem solving ability test
X: the PBL model uses a STEM approach (Giving Treatment)

The research instrument used is observation sheets for students, interview sheets for teachers, and pre-test and post-test which is compiled based on indicators of problem solving abilities in the form of multiple choice questions consisting of 10 questions. the test instrument is made based on the problem solving indicators of the citation results which include: problem identification, determining objectives, Developing solutions, Implementing solutions, and Evaluating Results.

Results pre-test and post-test analysed using the average calculation N-gain to measure the increase in problem solving abilities, then the results can be seen based on the score N-gain with the following interpretation (Table 2).

Table 2. Interpretation Gain Score

Normalized Gain Value	Interpretation	Normalized Gain Value
$<g>>0.70$	Low	$<g>>0.70$
$0.31< <g> \leq 0.70$	Moderate	$0.31< <g> \leq 0.70$
$<g> \leq 0.30$	High	$<g> \leq 0.30$

(Hake, 1998).

Result and Discussion

This research was conducted at one of the public junior high schools in Jombang City, with 32 research subjects and conducted over 2 meetings using he PBL learning model with the STEM approach on Ecology material, sub-subject Water Pollution. The result of pretest and posttest shows in table 3.

Tabel 3. Research Design One Group Pretest-Posttest Design

Pretest	Posttest	n-gain
42.81	78.13	0.57

Based on Table 3, mark pre-test used to determine the problem-solving abilities of students before learning is carried out which has a fairly low average score of 42.81. While the ability to solve problems after implementing learning has an average score the average is more than the result pre-test that is equal to 78.13. The results obtained were analysed using N-gain so that the average N-Gain value increased students' problem-solving abilities by 0.57 in the moderate category. Based on the test results of students' problem-solving abilities using worksheets designed using the PBL-STEM model, the test results increased, this shows that students' problem-solving abilities can be increased by habituating learning with the PBL-STEM model. This statement is supported by research conducted by Nilyani et al. (2023), which states that the PBL-STEM model produces positive effects for students, especially in improving thinking skills (critical thinking skill).

The impact of the PBL-STEM model on students' problem-solving skills may come from providing opportunities to solve river water pollution problems in the areas where students live. The process of delineating problem-solving and integration through STEM approaches requires students to master her four areas of knowledge relevant to the problem presented in order to find appropriate problem-solving methods. The final result of this lesson is a poster. Teachers lead learning activities and allow students to create simple water purification tools in the form of posters. Learning that requires students to be active in building their own knowledge will accustom students to independent learning and to think more systematically (Andrews et al., 2019; Hafni et al., 2020).

The data obtained from the students' pretest and posttest were based on 5 indicators of problem solving ability synthesized by the researcher, including problem identification; set goals; Develop solutions; solution implementation; and evaluation of results (Bransford & Stein, 1993; Foshay & Kirkley, 1998; Gick, 1986; Jonassen, 2011). Student test results based on 5 indicators of problem-solving ability can be seen in Figure 1.

Figure 1 shows the test results of students' problem solving abilities for each indicator. It can be seen that the lowest average is found in the evaluation results indicator while the highest average is the problem identification indicator. The following is a description of the students' solving abilities for each indicator.

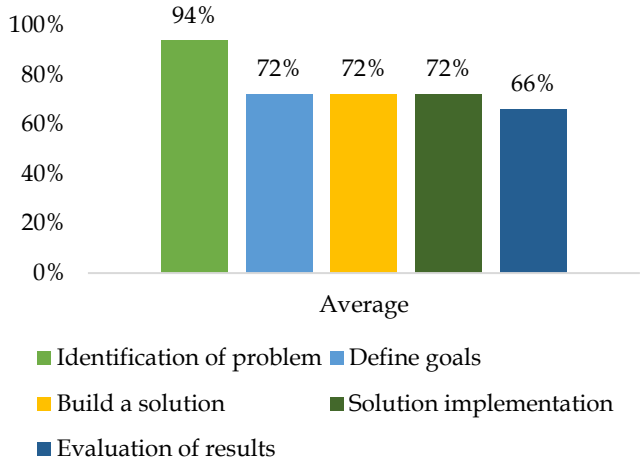

Figure 1. Students' Problem-Solving Skill

Identification of problem

The first indicator is problem identification, the average student obtained is 94% and is the highest average compared to other indicators, based on these results it can be concluded that students' ability to identify problems is very good. The ability to identify problems is the first step needed to solve a problem effectively and efficiently.

Define goals

Determining goals means sorting related information that leads to things that need to be done related to the problem to be solved, in this context, students are able to determine the direction that must be taken to solve the problem according to the identification of the problem that has been done.

Build a solution

Looking for alternative ways to solve certain problems through brainstorming and reviewing to make problem solutions, students have been able to develop solutions based on problem identification carried out through discussion activities

Solution implementation

Actions or implementation of methods that have been prepared or planned, solutions designed by students refer to the STEM approach, in this case students make a poster (Figure 4) as an embodiment of solutions related to water pollution problems.

Evaluation of results

Sequential assessment of results and evaluation of success to ensure problems have been resolved, This indicator has the lowest percentage, where it can be analyzed that students have not been able to judge whether the product made is able to answer existing problems or not.

Even so, this PBL-STEM learning activity is very well carried out by students, with the results that have been described students are very enthusiastic in learning so that the desire to learn is greater because the design of learning is fun, related to the results of problem solving abilities which are also good because this is a learning model something new for students so it needs more habituation to get better results.

Although the students' problem-solving skills are improving based on the n-gain results, the students are not as comfortable with learning as some of them, so the teacher puts more effort into guiding the course of learning activities. Case is confused as to what they are doing to schools that do things like this. If you are new to using this type of model, it will take some time, especially if you are incorporating STEM into their learning activities. Learning designed by the teacher uses the PBL-STEM model as outlined in the form of electronic worksheets, because this kind of learning is still new for students so that learning is designed as attractive as possible, one of which is by using learning media in the form of fish as objects that students observe. Electronic LKPD with the PBL-STEM model can be seen in Figure 2.

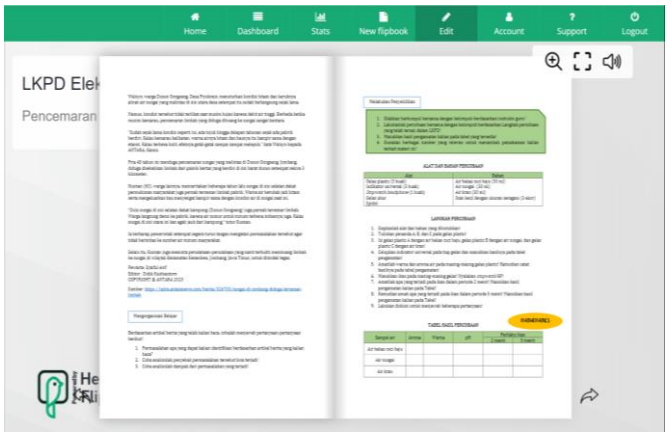

Figure 2. Electronic worksheet using PBL-STEM

In the STEM approach in learning the PBL model, students are instructed to open electronic LKPD and carry out activities based on the instructions in the Worksheet.

Learning with the STEM approach that is integrated with the PBL model makes students more active in learning because the problems they discuss come from the surrounding environment (real life problems) (Smith et al., 2022; Azhar et al., 2022). Although the PBL learning model with the STEM approach has some weaknesses, its implementation in learning activities is very important and this implementation requires the role of all parties, such as teachers, students, parents, and also other school members (Hasanah & Tsutaoka, 2019). This suggests that PBL model, using a STEM approach, includes the ability to show students the real benefits of the subject matter they are learning, thereby mastering the concepts of subject matter skills that underpin their development. This is because there are advantages such as being useful for Improving critical learning and thinking skills in problem solving (Parenta et al., 2022). By learning in a PBL model using a STEM approach, students not only memorize concepts, but also learn how to understand and understand the relationship between scientific concepts and everyday life, and solve problems. You will be able to use your knowledge when trying to solve problems and looking for different solutions (Ramlawati & Yunus, 2021).

Figure 3. student learning activities

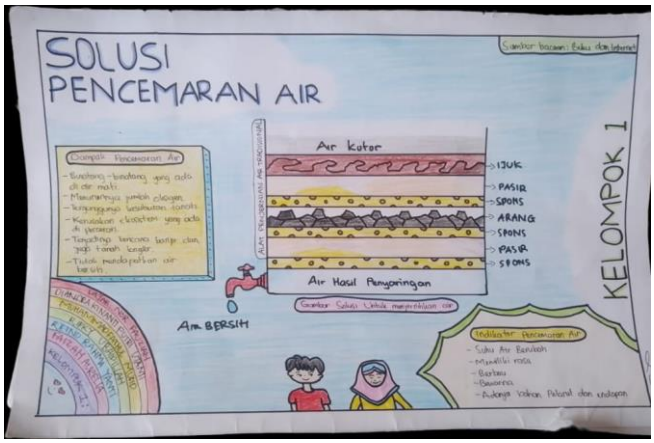

Figure 4. Poster for water pollution solutions by students

Conclusion

Based on the research that has been done, students' problem-solving abilities are included in the medium category after the PBL learning model is applied with a STEM approach. These results indicate that the learning activities of the PBL learning model with the STEM approach can train students' problem solving abilities, although it takes quite a long time in accordance with the initial abilities of students. Students who are familiar with HOTS questions will need a shorter time than students who are still in the LOTS position. For future researchers, can apply differentiated learning in the implementation of STEM learning, for example applying product differentiation learning in the implementation of STEM learning with the PBL model.

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Conflicts of Interests
The authors declare no conflict of interest.

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