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Implementation of HOTS-Oriented Problem Based Learning on Science Literacy Ability

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Abstract: Implementation of HOTS-Oriented Problem Based Learning on Science Literacy Ability. **Objectives:** Knowing and analyzing scientific literacy skills by applying the HOTS-oriented Problem Based Learning (PBL) model. **Methods:** The type of research in this research is experimental research. The research subjects were fourth grade students of SD Negeri 5 Metro Pusat. The research design used is a pre-experimental design and uses one form of design, namely the one group pretest-posttest design. The HOTS indicators used in this study are identify scientific issues (problems); explain scientific phenomena; using scientific evidence **Findings:** Based on the results of the data analysis, the pretest score for the scientific literacy ability of students achieved by the experimental class was 9.25 and the posttest score was 11.90. **Conclusion:** The results of the research that have been carried out show that the application of high order thinking skills (HOTS) based on problem based learning (PBL) to improve scientific literacy skills has the impact of increasing n-gain by 0.21 in the low category. In the analysis of the average n-gain score on the highest scientific literacy ability indicator, namely the use of scientific evidence.

Keywords: higher order thinking skills, problem based learning, science literacy.

Abstrak: Implementasi Pembelajaran Berbasis Masalah Berorientasi HOTS terhadap Kemampuan Literasi Sains. ***Tujuan:*** *Mengetahui dan menganalisis kemampuan literasi sains dengan menerapkan HOTS berbasis problem based learning.* ***Metode:*** *Jenis penelitian dalam penelitian ini adalah penelitian eksperimen. Subyek penelitian adalah siswa kelas IV SD Negeri 5 Metro Pusat. Desain penelitian yang digunakan adalah pre-experimental design dan menggunakan salah satu bentuk desain yaitu one group pretest-posttest design. Indikator HOTS yang digunakan dalam penelitian ini adalah mengidentifikasi isu ilmiah (problem); menjelaskan fenomena ilmiah; menggunakan pembuktian ilmiah..* ***Temuan:*** *Berdasarkan hasil analisis data, nilai pretest kemampuan literasi sains siswa kelas eksperimen adalah 9,25 dan nilai posttest adalah 11,90* ***Kesimpulan:*** *Hasil penelitian yang telah dilakukan menunjukkan bahwa penerapan keterampilan berpikir tingkat tinggi (HOTS) berbasis problem based learning (PBL) untuk meningkatkan kemampuan literasi sains berdampak pada peningkatan n-gain sebesar 0,21 pada kelompok rendah. kategori. Pada analisis rata-rata skor n-gain pada indikator kemampuan literasi sains tertinggi yaitu penggunaan bukti ilmiah.*

Kata kunci: *keterampilan berpikir tingkat tinggi, pembelajaran berbasis masalah, literasi sains.*

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INTRODUCTION

Science as a scientific product is a collection of knowledge consisting of: facts, concepts, propositions, principles, laws, theories, and models. Science as a process is a collection of hands-on activities, experiments, and projects aimed at investigating the wonders of the world (Sukerti et al., 2017). Science is related to how to find out about nature systematically, so that science is an experiential process that results in mastery of knowledge in the form of understanding concepts. One of the efforts to face the demands of the 21st century is to develop one's literacy skills or abilities that can be used to face the challenges of today's life (Wahyuningsih, 2021). Literacy is an ability or skill in reading, mathematics and science.

Scientific literacy is a goal to be achieved by subjects that are based on science (Sutrisna, 2021). The applied science learning does not provide opportunities to actively carry out activities that can develop scientific literacy skills and lacks developing science process skills, only product-oriented (Pratiwi et al., 2019). In addition, learning is carried out classically and conventionally, so that it does not develop student cooperation (Turdjai, 2016). Whereas direct observation of objects can provide a different experience for students compared to just listening to explanations.

All of these explanations are a factor in the low process skills and scientific literacy abilities of students (Rahmatullah et al., 2021). Improving process skills and scientific literacy skills in learning activities is very important in order to create a science-literate and character-driven society (Kurniawati & Hidayah, 2021). Scientific literacy is one of the problems that is quite important and must be addressed in Indonesia.

In line with the explanation above, more and more researches related to scientific literacy are being carried out, this is very likely to happen because the development of world scientific literacy is getting more attention, this can be seen from the OECD program, namely PISA which always improves its survey results every three years. The latest results, namely PISA 2012 show that the average scientific literacy of students is 382 with an average of 501 and is ranked 64th out of 65 participating countries (Sellar & Lingard, 2014). Meanwhile, in 2009 the results of the PISA survey showed that the average scientific literacy of Indonesian students was 383 with an average of 501 and ranked 59 out of 65 participating countries ((OECD), 2010).

The results of this three-year research also reveal that there are variations in the acquisition of scientific literacy achievements based on three aspects (Sukowati et al., 2017). First, the aspect of the school's role is proven to have an effect on the achievement of students' science scores, it is recorded that students who get high scores for scientific literacy because of the role of the principal, namely carrying out their responsibilities for good school governance, their students are recorded to achieve higher scores in terms of science. If the proportion of principals who monitor student achievement and report publicly is higher, then their PISA achievement rate is shown to be higher.

From the results of observations in elementary schools, the learning process carried out is still centered on educators, so it can be seen that students' scientific literacy skills are still low (Merta et al., 2020). The low level of scientific literacy can be seen from the number of students who have difficulty understanding and analyzing science learning materials (Suparya et al., 2022). In addition, low scientific literacy will have an impact on the occurrence of misconceptions in science material so that learning outcomes for cognitive, affective, and psychomotor abilities are low.

One way to improve scientific literacy skills is to apply questions containing High Order Thinking Skills (HOTS) which are applied in the National Examination (UN) and are the implementation of the 2013 Curriculum which requires students to have high-level thinking skills (Dinni, 2018). HOTS includes problem solving skills, critical, logical, creative thinking skills, argumentation skills, and critical thinking skills (Widodo & Kadarwati, 2013). The application of HOTS questions can measure the ability to: (1) transfer one concept to another; (2) processing and applying information; (3) looking for links from different kinds of information; (4) use information to solve problems; and 5) critically reviewing ideas and information (Tune Sumar & Tune Sumar, 2020).

In addition to the application of HOTS in the learning process, students can use a problem-solving-based learning model that must be owned by students to solve various problems, both mathematical problems and problems in everyday life. The importance of scientific literacy for everyone as a citizen, citizen and citizen of the world has been realized in developed countries. Every citizen needs to have a level of scientific literacy in order to survive in nature and in the place of work armed with the knowledge, understanding, skills and values contained in it. With various problems that exist at the basic education level, it is necessary to increase scientific literacy skills. The application of the problem-solving learning model is expected that students will be able to have better scientific literacy skills, especially in studying science related to the basic concepts of science. Based on this, the researchers will see the ability of scientific literacy by applying HOTS based on problem solving. Therefore, researchers are interested in researching "Implementation of High Order Thinking Skills (Hots) Based on Problem Based Learning on Scientific Literacy Ability".

METHODS

Participants

This research was conducted at SD Negeri 5 Metro Pusat having the address Jl. MajorJendral Riyachudu No. 16, Metro, Kec. Metro Pusat, Kota Metro. The collection and processing of research data were carried out in April – August 2021. The populations in this study were all fifth-grade students of SD Negeri 5 Metro Pusat as many as 59 students.

Samples were taken using non-probability sampling techniques, namely saturated samples; where all members of the population are used as samples (Sugiyono, 2016). Thus, the sample is 59 students of class IV SD Negeri 5 Metro Pusat.

Research Design and Procedures

The type of research in this research is experimental research. The research design used is a pre-experimental design and uses one form of design, namely the one-group pretest-posttest design. This design uses one group, as an illustration, the experimental group. The experimental group is a class that receives treatment in the form of applying the HOTS-oriented Problem Based Learning (PBL) model. The treatment is intended to increase Science Literacy Ability (SLA). The HOTS-oriented PBL model which is meant as a learning process that presents phenomena or problems of everyday life to hone students' HOTS so that solutions to these problems (Abdulrozzak, 2016) . HOTS activities in question are thinking activities to identify scientific issues (problems); to explain scientific phenomena; to use scientific evidence.

Pretest before doing the treatment for the experimental class can be used as a basis for determining changes. Giving the posttest at the end of the treatment will show how significant

the effect on the treatment is. After knowing the initial test and the final test, the difference is calculated.

Instruments

The data collection technique used is the test technique to determine the level of science literacy ability of students in science learning in elementary schools. The test is carried out at the beginning of learning before students get the material (pretest) and at the end of learning after students get the material (posttest). The instrument is structured based on 3 indicators of SLA, namely: (1) Identifying scientific issues (problems); (2) Explaining scientific phenomena; and (3) Using scientific evidence (Gormally et al., 2012).

Each SLA indicator consists of 2 question items to be tested on students. Based on the results of the expert test, the instrument was declared valid with a score of 3.71 (on a scale of 1-4). This proves that the question items are in accordance with the SLA indicators. In addition, the instrument was also tested to determine validity and reliability. Based on statistical analysis of data from 44 students using Microsoft Excel, 6 items were declared valid with scores of 0.36, 0.39, 0.57, 0.34, 0.37, and 0.41 (r_{table} = 0.291 and a significance level of 5%). This instrument was also declared reliable with a Cronbach's Alpha value of 0.67.

Data Analysis

Students' SLA data was analyzed statistically using Microsoft Excel. There are 2 statistical tests performed, namely the prerequisite test and the effect test. Prerequisite tests include tests for normality and homogeneity of data. The effect test used independent sample test (t-test) to determine whether there is an effect of the HOTS-oriented PBL model on SLA. In addition, the N-Gain test was carried out to determine the effectiveness of implementing the action.

■ RESULTS AND DISCUSSION

The Results of Prerequisite Test

Based on the results of statistical tests, $x^2_{\text{hitung pretest}} = 7{,}948$ for pretest score and $x^2_{\text{hitung posttest}} = 6{,}348$ for posttest score. Consider $x^2_{\text{tabel}} = 11{,}07$, thus it can be conveyed that pretest dan posttest scores are normally distributed. Moreover, statistics analysis informed that F_{calc} = 1.05 with F_{table} 1.88. It can also be conveyed that the variance of the pretest and posttest is homogeneous.

Based on the statistical test results, the value $x^2_{\text{pretest count}} = 7{,}948$ for pretest data and $x^2_{\text{posttest count}} = 6{,}348$. Considering the value of $x^2_{\text{table}} = 11{,}07$, it can be stated that the pretest and posttest data are normally distributed. Furthermore, statistically, the value of F_{count} = 1.05 is obtained. With a F_{table} value of 1.88, it can be stated that the variance of the pretest and posttest is homogeneous.

N-Gain of SLA

Based on the average pretest and posttest scores of the experimental class, the average normalized gain (n-gain) is 0.21 in the low category. Secara rinci, nilai rata-rat n-gain untuk setiap indikator SLA disajikan pada Gambar 1 berikut ini.

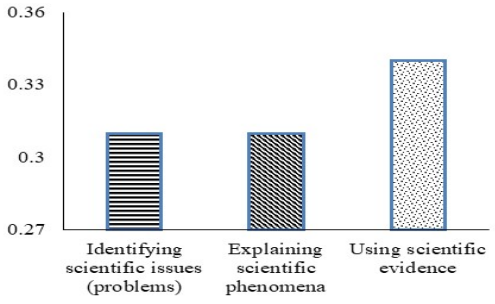

Figure 1. N-Gain of SLA Indicators

Based on Figure 2. the average value of the normalized gain for SLA in the experimental class on the indicator of identifying scientific issues (problems) is 0.31, the indicator explaining

scientific phenomena is 0.31, and the indicator using scientific evidence is 0.34.

The Results of Independent Sample Test

Berdasarkan independent sample test, diperoleh nilai $t_{hitung} = 2.00$ dengan nilai $t_{table} = 3.03$, maka dapat dinyatakan bahwa there is a positive and significant effect on the implementation of HOTS -oriented PBL model on SLA.

The results of the research that have been carried out show that the application of high order thinking skills (HOTS) based on problem-based learning (PBL) to improve scientific literacy skills has the impact of increasing n-gain by 0.21 in the low category. In the analysis of the average n-gain score on the highest scientific literacy ability indicator, namely the use of scientific evidence. From the results of the t test, the scientific literacy ability of students is 3.03> 2.00 with a significance level of 0.05, this indicates that there is a positive and significant influence on the implementation of PBL-based HOTS on scientific literacy skills.

Based on the research results, the HOTS-oriented PBL model can stimulate students to analyze problems, formulate hypotheses, collect data, analyze data and conclude answers to the problems given. This model provides an opportunity for students to find their knowledge and play an active role in learning so that they can understand concepts well and develop critical thinking skills. Thus, students can easily identify scientific issues based on the current phenomena given, which are part of the SLA. In other words, this model trains problem-solving skills through systematic steps so that students will be more critical in finding solutions to a problem. These activities are supported by scientific evidence found during the learning process. This shows that the selection and use of models are necessary in improving the quality of learning in schools (Fadly, 2012).

Learning activities by applying the HOTS-oriented PBL model begins with identifying phenomena and problem formulation (Magsino, 2014; Yonata, 2013). Then, the activity continued with determining temporary answers and investigations. The investigation results data presented became the basis for discussion activities. In this activity, students in each group criticize each other so that they focus on problem-solving solutions. The activity ends with concluding.

Activities in the HOTS-oriented PBL model are very important to support students in the learning process (Umamah et al., 2018). This is quite useful for students to deal with problems commonly found in their daily lives. This considers that the problems presented are phenomena that occur both in the school environment, at home, and in the community as a basis for acquiring knowledge and concepts of learning materials. This problem is used to relate curiosity and analytical skills and students' initiative to the subject matter. Through the problems faced by students, they can develop SLA, namely the ability to identify scientific problems. Students find it easier to uncover facts in the field, where these facts are then linked to one another to form a concept (Sukamto et al., 2022). This concept is the basis for solving problems in a structured way. Thus, the formed HOTS is important for students' mindsets. These are also seen as basic competencies, like the ability to read and write. HOTS can make students improve their performance and reduce their weaknesses (Feronica et al., 2021).

The findings from these activities can develop students' scientific literacy competencies in the form of the ability to use scientific evidence (Asyhari, 2015). Scientific evidence that has been obtained from various reliable sources is then interpreted and reduced by students which directs students to problem-solving. Through scientific evidence and findings, students can

also explain scientific phenomena. Student's ability to use scientific evidence and explain scientific phenomena can be further developed through classroom discussion activities facilitated by the teacher, in which students express their opinions orally and in writing on their group's findings.

SLA mastery can also be seen through student activities in groups in conveying ideas that make it possible to help the problem-solving process. Problems are solved through a series of useful information searches based on the phenomena presented (Asyhari, 2015). The HOTS-oriented PBL model also allows students to communicate and collaborate in the form of communicative scaffolding and collaborative debugging (Weng et al., 2022). Thus, creativity is formed in the form of creative exploration, creative solutions, and creative expression.

Thus, scientific literacy related to science material pays attention to cognitive and affective aspects. The cognitive aspect includes knowledge and its capacity to use knowledge effectively and involves cognitive processes that are characteristic of science in the personal, social and global fields. The affective aspect relates to problems that can be solved with scientific knowledge and forms students who can make decisions now and in the future.

■ CONCLUSIONS

Based on the results of the research and discussion presented earlier, the application of problem-based learning-based high order thinking skills (HOTS) to scientific literacy skills from data analysis, the pretest score of students' scientific literacy skills achieved by the experimental class was 9.25 and the post-test score was 11.90. Improving scientific literacy skills has an impact on increasing n-gain by 0.21 in the low category. In the analysis of the average n-gain score on the highest scientific literacy ability indicator, namely the use of scientific evidence. From the results of the t test, the scientific literacy ability of students is 3.03 > 2.00 with a significance level of 0.05, this indicates that there is a positive and significant effect on the implementation of PBL-based HOTS on scientific literacy skills.

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