

Increasing Students's Higher Order Thinking Skills Through Developing Scientific-Based Learning Scenarios

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Abstract

The results of the PISA survey in 2015 and 2018 have decreased, indicating that the Higher Order Thinking Skills of students are not optimal so that more effective learning scenarios are needed. The purpose of this study is (1) to describe the characteristics of scientific-based learning scenarios, (2) the development of scientific-based learning scenarios, and (3) to determine the effectiveness of scientific-based learning scenarios to improve students' HOTS. This research and development use a modified method Sukmadinata and Thiagajaran, et al. which consists of define, design, development and disseminate phases. The research subjects were fourth-grade students of Elementary Schools in Ngawi Regency. Data collection techniques used the HOTS test and teacher and student response questionnaires. The HOTS data analysis technique used Independent Sample T-Test based on the pretest and posttest gain scores in the experimental and control groups. The results of the gain score analysis show a significance level of 0.019 less than $\alpha = 0.05$ so that H_0 is rejected, which means that there are differences in the HOTS students in the experimental and control groups. This shows that the use of scientific-based learning scenarios can increase the HOTS fourth-grade students at Elementary Schools in Ngawi Regency. Improving teachers' ability to design scientific-based learning designs is one of the important proofs of changes in learning made by teachers toward achieving students' abilities in the future.

Keywords

Learning Scenario; Scientific-Based Learning; Higher Order Thinking Skills



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INTRODUCTION

Indonesia has entered the fourth industrial revolution, which has an impact on how the educational system is implemented. Higher-order thinking skills, or HOTS, are a prerequisite for students in order to prepare them for the highly competitive millennial era. Indonesia was placed 64th out of 65 nations in terms of reading, arithmetic, and scientific literacy in PISA statistics from 2012 (OECD, 2012), while Indonesia was placed 74th out of 79 nations in 2018 (OECD, 2018). Indonesian students are only used to responding to PISA questions at the level 1 and level 2 levels (Kertayasa, 2014) which is limited to the ability to recognize facts, objects, and technical characteristics (Setiawan et al., 2014). The PISA test consists of contextual questions that provide real-world situations and require students to use creativity, logic, and reasoning to solve them (Wardhani & Rumiati, 2011).

Based on the pretest HOTS of students at five elementary schools in Ngawi Regency consisting of Kedunggalar 1 Elementary School, Tanjungsari 3 Elementary School, Gemarang 6 Elementary School, Kedungputri 1 Elementary School, and Margomulyo 1 Elementary School with a total of 183 students as respondents, the data obtained that students with HOTS scores below the average are 94, while students with scores at the limit and above the average are 89. This shows that the implementation of learning has failed to maximise HOTS for half of the total number of students.

Because teachers are not prepared and students are not accustomed to taking an active role in their education, one of the reasons why students' higher-order thinking skills are not fully developed is because learning is still teacher-centered (Fakhomah & Utami, 2019). Students are used to doing things based on adult decisions since childhood so that students become passive and not independent (Pekince & Avci, 2018), even though elementary school students are considered to have been able to make decisions through questioning and evaluating activities (Kaşkaya et al., 2017).

The education system in Indonesia carries learning which is designed to generate higher-order thinking skills for the nation's next-generation (Kemendikbud, 2014). The latest Indonesian curriculum includes the use of a scientific approach as a guideline in introducing learning. Learning with a scientific approach is part of active student-centered learning (Rostika & Prihantini, 2019), but the implementation of the Ministry of Education and Culture's Guideline Books has not been able to optimize students' HOTS. Based on the facts regarding the problems that occurred, it is necessary to develop a scientific component to be integrated into learning scenarios in a single unit that is oriented to increasing students' HOTS.

The enhancement of higher-order thinking skills (HOTS) through scientifically grounded learning situations is the subject of this study. Although scientific-based learning has been applied extensively in earlier research, it has rarely been employed to enhance students' capacity for higher order thinking. The study "Implementation of the Scientific Approach, Character Building and Conservation in Learning Growth Materials" by (Machin, 2014) focused on learning material mastery and character education. Similarly, research on the "Effectiveness of the Scientific Approach to Improve Student Learning Outcomes" compiled by Firman et al. (2018) is focused on enhancing student learning outcomes. In this study, researchers attempt to provide a product in the form of a guidebook that contains a collection of scientific-based learning scenarios in order to give teachers convenience and eliminate the burden of assembling scientific-based learning. However, research on scientific-based learning is also restricted to implementation during the study.

The development of learning scenarios with the scientific components was chosen because the scientific approach is very familiar to teachers, so it is hoped that teachers can adapt more easily to the products developed. Scientific-based learning is believed to affect the development of students' skills (Ariyana et al., 2018) one of which is higher-order thinking (HOTS) (Abdullah & Osman, 2010). This shows that scientific-based learning has a positive influence on the improvement of students' higher-order thinking skills. However, little research has specifically developed scientific-based learning scenarios to improve the HOTS of elementary school students in Ngawi Regency. Therefore, this study aims to fill this gap.

The scientific-based learning scenario contains 5 components, namely observing, asking, trying, reasoning, and communicating with certain provisions accompanied by HOTS questions. HOTS questions will train students to get used to thinking critically to be able to train themselves to become problem solvers. Higher-order thinking skills applying previously acquired knowledge or information and manipulating it to arrive at potential solutions or responses in unexpected circumstances. (Kusuma et al., 2017). Higher-order thinking skills are then attached to the personality of students, so that critical thinking is no longer coercion from teachers or learning but because students are used to it. Students with good critical thinking skills will also provide a spur for teachers to further improve quality to provide learning services for students. Based on this, this research aims to improve students' higher-order thinking skills through the development of learning scenarios integrated with a scientific approach.

METHOD

The development steps in this research were carried out comprises three phases: initial research, development of products, and testing of products (Sukmadinata, 2007). The preliminary study phase is carried out through library research and needs analysis in the field for the preparation of a draft of the product being developed. The product development stage is carried out by conducting a limited trial and a broad trial. The testing phase is carried out through pretest and posttest as well as questionnaires for responses from teachers and students to determine the efficiency of the developed product. The research procedure was modified with the Four-D model developed by (Thiagarajan et al., 1974) which included Define, Design, Development, *and* Disseminate. Modifications Four-D and Sukmadinata development models are shown in Figure 1 below.

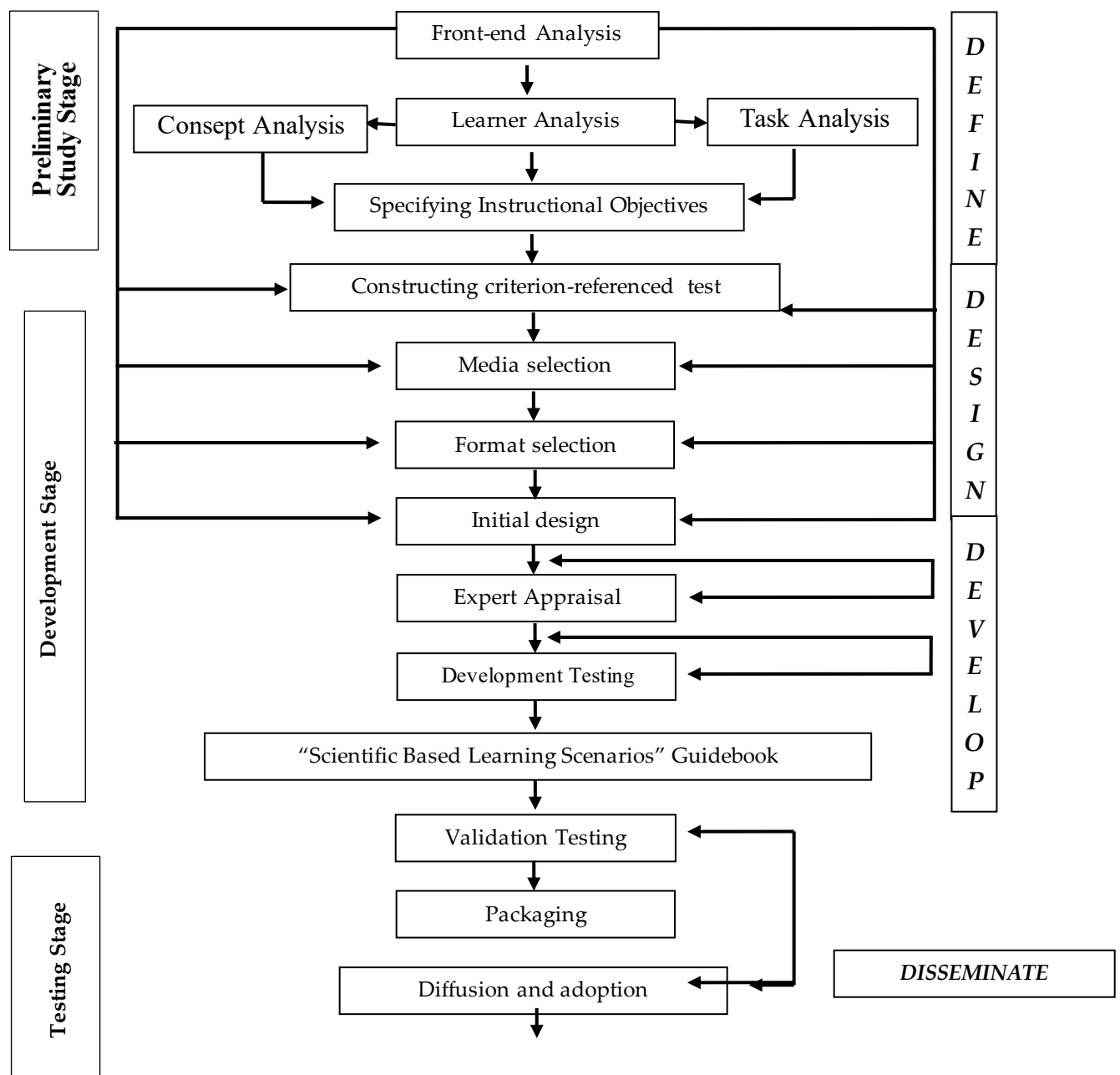


Figure 1. Four-D and Sukmadinata Modified Development Model

Participants in this research were teachers and students of fourth-grade elementary schools from four elementary schools in Ngawi Regency, including Tanjungsari 3 Elementary School, Gemarang 6 Elementary School, Kedungputri 1 Elementary School and Margomulyo 1 Elementary School in Ngawi Regency. Teachers and 11 students of Tanjungsari 3 Elementary School as limited trial subjects, 35 students of Gemarang 6 Elementary School and Kedungputri 1 Elementary School as subjects of a broad trial, and 50 students of Margomulyo 1 Elementary School as experimental and control groups in the effectiveness test.

Data collection was carried out through response questionnaires and Higher Order Thinking Skills tests. The HOTS questionnaire and test were tested on 40 students of Kedunggalar 1 Elementary School. Based on Pearson's product moment correlation, the questionnaire was declared valid with r_{count} greater than r_{table} at a significance value of 0.05 and deemed reliable with a Cronbach Alpha of 0.70. The preparation of the HOTS test is based on fundamental competencies and measures of competency attainment. that have been set in the thematic book Theme 2 Sub-theme 1 fourth grade elementary school. Based on point biserial analysis on ITEMAN, 30 HOTS questions were declared valid with a reliability coefficient resulting in a score of 0.82.

RESULT AND DISCUSSION

Result

Preliminary Study

Preliminary study is a define phase in research that aims to find solutions to problems that occur in the field. Preliminary studies analysis are presented in table 1.

Table 1. Results of the preliminary study stage analysis

Analysis Focus	Explanation
Front-End Analysis	Learning guided by thematic books from the government and other supporting books (LKS). Thematic books from the government are considered to be very general/global so teachers use other learning resources. Learning scenarios based on thematic books are considered not sufficient to present learning to develop students' thinking skills, especially HOTS
Learner Analysis	Fourth-grade students are in the stage of concrete operational cognitive development who have been able to think logically in understanding and organizing concepts rationally and systematically and have good potential for thinking skills to begin to be developed higher
Consept Analysis	Scientific-based learning scenarios are prepared by taking into account the supporting components in the form of teacher thematic books, student thematic books, trusted internet sources, such as pictures, videos, and texts, and other references that are following the material in Theme 2 Sub-theme 1 for fourth-grade elementary school.
Task Analysis	The HOTS-oriented assessment has been mandated by the Ministry of Education and Culture in 2013 to develop students' thinking skills to face future challenges.
Specifying Instructional Objectives	The specification of the learning objectives is students' higher-order thinking skills with the HOTS question instrument compiled with the indicators used to develop students' abilities, namely: analyzing, evaluate and create.

Scientific-Based Learning Scenario Development

The development phase includes the design phase and the development phase. The design stage is the stage of preparing a product development draft for Scientific-Based Learning Scenarios and HOTS instruments. Followed by the development stage which includes the expert validation stage, limited trials, and broad trials.

The response questionnaire instrument was declared valid with r_{count} greater than r_{table} at a significance value of 0.05 and deemed reliable with value Cronbach's Alpha of 0.70. The HOTS question instrument is deemed valid based on the points biserial of the ITEMAN results. HOTS questions are declared reliable based on the coefficient alpha which is 0.82 with very good reliability information.

Product validated to experts to determine the feasibility of the products developed before field trials were carried out. Expert validation in product development of scientific-based learning scenario guide books involves material experts and linguists. Material expert validation includes three aspects of material feasibility, namely aspects of conformity with Core Competencies (KI) and Basic Competencies (KD), product component aspects and learning aspects, meanwhile the aspects assessed by linguist include: (1) the spelling used is correct, effective, and following PUEBI, (2) the language used is simple to understand by the reader and does not cause double meaning, (3) the legibility of the product is good and contains clear information, and (4) consistent use of terms, symbols and icons. The results of material expert validation 1 and 2 were 3.60 and 3.80, respectively, which stated that the product had a very good category. The validation of linguists 1 and 2 gave the same average score of 4.00, which means the product has an excellent category that performs effectively for product trials.

The limited trial was carried out in Tanjungsari 3 Elementary School, Jogororo District, Ngawi Regency with a total of 11 fourth grade students. The results of the teacher's response questionnaire showed that overall both technical, language, material, and learning aspects were stated to be excellent with an average value of 3.68. The student response questionnaire consisted of 15 assessment items which showed that 57.7% stated strongly agree, 40.2% agreed and 2.1% stated less agree that learning with scientific-based learning scenario has good feasibility.

The broad trial phase was carried out to measure the Higher Order Thinking Skills (HOTS) of students in two elementary schools, namely Gemarang 6 Elementary School in Kedunggalar District and Kedungputri 1 Elementary School in Paron District with a total of 35 students. The data pretest

and posttest of the broad trial had differences before and after using the scientific-based learning scenario. The comparison of the HOTS scores of pretest and posttest students in the broad trial is shown in Figure 2.

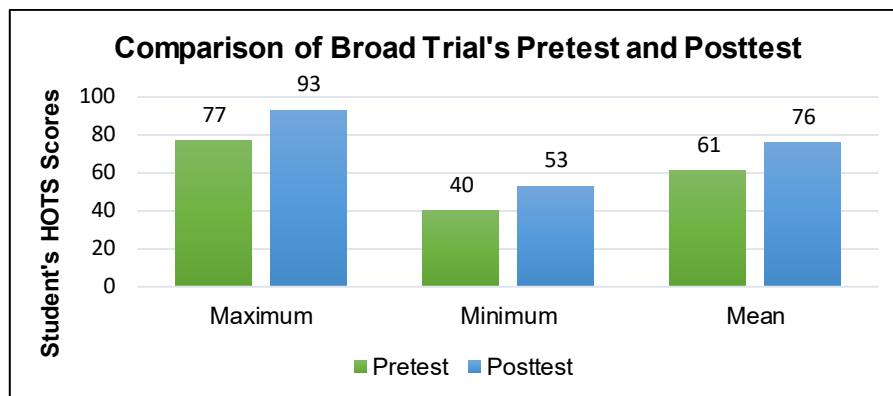


Figure 2. Students HOTS Scores of Pretest and Posttest in the Broad Trial

Data were analyzed by Paired Sample T-Test with prerequisite tests, namely normality and homogeneity test. Results Paired Samples T-Test showed pretest and posttest has a significance level of 0.000 is less than $\alpha = 0.05$ so the fact that H_0 is rejected suggests that the HOTS students' values were different before and after the scientifically based learning scenario was used.

Effectiveness Test of Scientific-Based Learning Scenarios

The testing phase is the disseminate phase, which includes validation testing or effectiveness testing, packaging as well as absorption and adoption. The effectiveness A test was conducted to ascertain the effectiveness of the product "Scientific-Based Learning Scenario Guide Book" to improve student HOTS carried out at Margomulyo 1 Elementary School with a total of 50 students with details of 25 students in class IV A that served as the experimental group and 25 students in class IV C that consisted the control group. HOTS student pretest and posttest data for the experimental and control classes are shown in table 2.

Table 2. Data from the experiment and control class's HOTS pretest and posttest

Group	N	Maximum	Minimum	Mean
Pretest				
Experiment	25	83	33	65
Control	25	87	47	69
Posttest				
Experiment	25	93	60	77
Control	25	83	47	69

Data that has been obtained, then analyzed and used to determine the results of the prerequisite tests, namely the normality test, homogeneity test, and balance test with SPSS version 24. The outcomes of the prerequisite test analysis at the testing stage are displayed in table 3.

Table 3. Results of Prerequisite Test Analysis Testing Phase

Test	Test Type	Sign.	Decision	Conclusion
Pretest Normality				
Experiment	Kolmogorov	0,200	H ₀ accepted	Normal Data
Control	Smirnov	0,200	H ₀ accepted	Normal Data
Posttest Normality				
Experiment	Kolmogorov	0,200	H ₀ accepted	Normal Data
Control	Smirnov	0,088	H ₀ accepted	Normal Data
Homogeneity				
Experiment	Levene's Test	0,471	H ₀ accepted	Homogeneous Data
Control		0,693	H ₀ accepted	Homogeneous Data
Balance Test	Independent Sample T-Test	0,263	H ₀ accepted	No Difference
Effectiveness Test	Independent Sample T-Test	0,019	H ₀ rejected	There is Difference

The effectiveness test was conducted using the Independent Sample T-Test through the gain score data, namely the distinction between the scores pretest and posttest in the two groups. The results of the analysis gain score showed a significance level (2-tailed) 0.019 less than $\alpha = 0.05$ so that H₀ is rejected, indicating that there are differences in student HOTS in the experimental and control groups. After the implementation of the scientific-based learning scenario, the average experimental group was better than the control class. Based on this statement, it shows that the application of the "Scientific-Based Learning Scenario" Guidebook can enhance the Higher Order Thinking Skills of fourth-grade students at Elementary School in Ngawi Regency.

The packaging stage is carried out after the product has been declared capable of improving the Higher Order Thinking Skills students'. This research's final output is a guidebook which is presented in two forms, namely printed book and e-book. The final product packaging can be seen in the Figure 3.

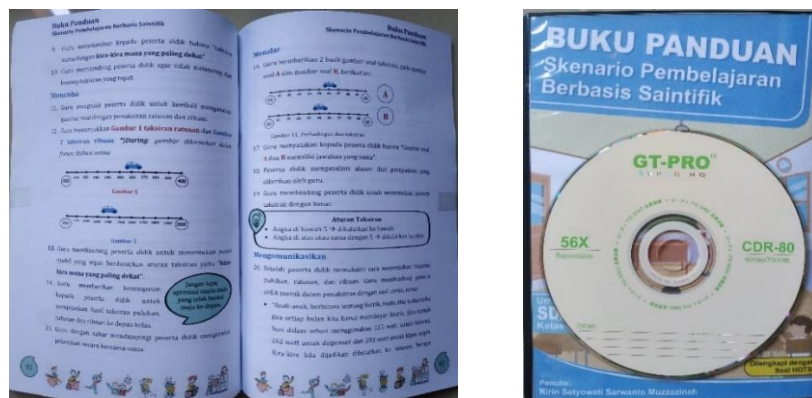


Figure 3. Scientific-Based Learning Scenario Guide Book Print Version and E-Book

The absorption and adoption stages are carried out to disseminate the products that have been developed by providing a Scientific-Based Learning Scenario Guidebook document to teachers and principals at each educational institution in research as well as compiling scientific articles with the theme of scientific-based learning scenarios and *Higher Order Thinking Skills* for fourth-grade students have been held in national and international seminars.

Discussion

Characteristics of Scientific-Based Learning Scenarios include 2 aspects, namely the components contained in the guidebook and the scientific component indicators that have been developed. In the guidebook, there is a brief theoretical description consisting of several sub-chapters, including “What is scientific?”, “How important is the preparation of learning scenarios?”, “Is it necessary to develop a scientific component?”, and “An Overview Higher Order Thinking Skills”. Elements of scientific-based learning scenarios consist of a theme/subtheme/ learning titles, subjects, learning objectives, fundamental competencies, and measures of competency attainment; simple tools and media; learning steps are equipped with supporting pictures, the concept of knowledge of each subject; and notes for teachers, HOTS Theme 2 Sub-theme 1 questions and answer keys, a list of sources used, and a glossary. Some of the elements in the scientific-based learning scenario are shown in the figures below.

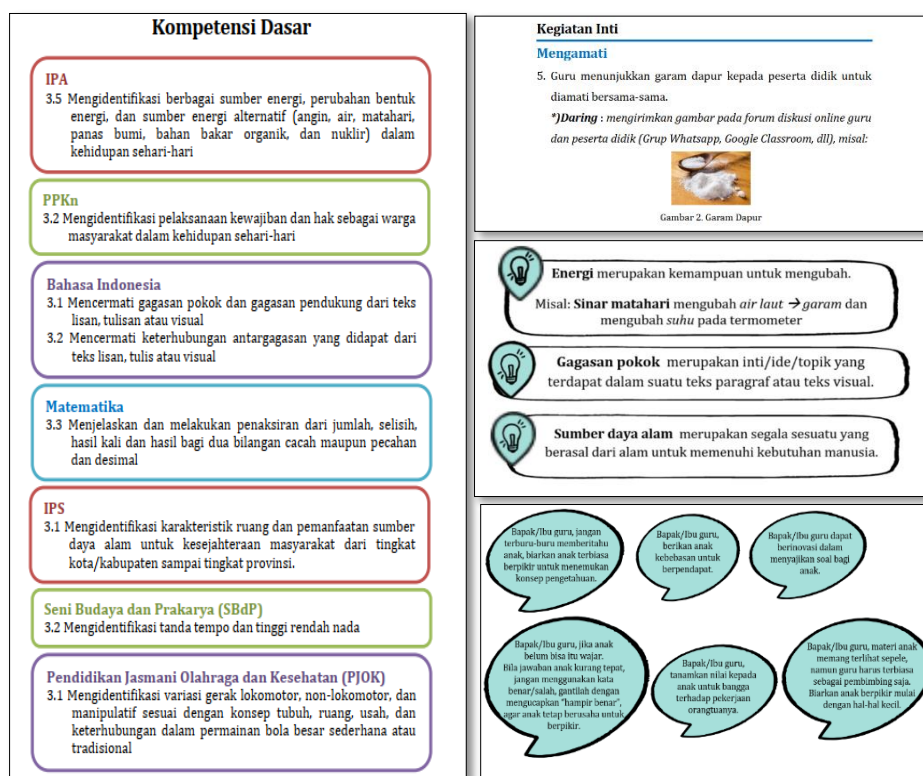


Figure 4. Elements of Scientific-Based Learning Scenario

Indicators of scientific-based learning scenarios consist of five scientific components that have been developed, including: (1) **observing**, observing activities in scientific-based learning scenarios emphasize the use of real objects that are familiar to students to start learning, because they affect interest in learning and trigger students to think critically (Hasanah, 2018); (Khofiyah et al., 2019); (2) **asking**, not specified in detail because the question must come from students' curiosity about learning (Supriatna, 2019) and aims to stimulate students to get used to expressing their questions or thoughts (Sugiarti, 2015); (3) **trying**, by using simple tools or media so that teachers do not feel burdened with complicated preparations and seek simple and fun activities such as playing which aims to provide learning satisfaction (Ifrianti, 2015); (4) **reasoning**, emphasizing on one concept of knowledge in a subject only, because the large number of material loads causes students not to be interested in finding out (Sieberer-Nagler, 2016) and avoids the loss of student motivation during learning, because the main focus in reasoning activities is think so that learning is kept interesting (DiCarlo, 2009); and (5) **communicating**, not fixating on whether or not the information concluded by students, but getting students used to presenting the information that has been obtained to appreciate the results of the student learning process as a form of reinforcement (Niswaty et al., 2017).

Teachers aim to highlight students' HOTS by maximizing the steps in the scientific-based learning scenario during instruction. Students have attempted to explain the information on how salt is generated from seawater in the extensive trial during learning 1, demonstrating their ability to express their ideas on the process. The first stage to developing higher-order thinking abilities is being able to express opinions (Davidson & Berninger, 2016).

In the second lesson, students began to dare to discuss the content on sorts of natural resources with both teachers and peers, which received a great response from students, who took turns offering natural resource instances. In this assignment, students have begun to actively build learning concepts, allowing them to effectively arrange information regarding renewable and non-renewable natural resources. The teacher also assigns students to be asked one example of a natural resource, identifying its type and why, and some kids respond effectively. As stated by Hubers (2022) this shows students' ability to use logic and evidence to support their ideas, thereby forming higher-order thinking skills that require analysis of cause and effect.

Students warmly welcomed third lesson, which focused on Physical Education, Sports, and Health. Reasoning exercises in this class need students to be able to distinguish between locomotor, non-locomotor, and manipulative motions from moving images (gifs) displayed by the teacher that were executed correctly. Students were able to immediately identify the differences between the three movements, which supports proposition Evitasari (2019), which states that students' ability to compare knowledge with one another can promote higher-order thinking skills through the action of evaluating and concluding.

In the fourth lesson, students examine the usage of toy car and number lines as media to comprehend the notion of estimation in mathematics. In this lesson, students are instructed to study and determine the car's position on the number line that is closest to the accurate estimate. Based on the results of the learning process, students can use these resources to answer estimation questions. This demonstrates that students can plan procedures to solve problems involving numerous types of questions. The ability to apply knowledge to solve issues is an example of high-level thinking at the planning and assessment levels (Saraswati & Agustika, 2020).

Considering the outcomes of the response questionnaire, it shows that scientific-based learning affects student communication because the intensity of better interaction between teachers and students makes the ability to communicate better than giving assignments (Widiani et al., 2016). The ability and understanding of the material is also better if the learning is carried out by a

scientific-based learning scenario, because it is considered more interesting (Putra & Hanggara, 2019). The outcomes demonstrated that there were significant differences in students' HOTS test results before and after carrying out scientific-based learning. Similar results were also proven by research by (Riadi & Retnawati, 2014), (Purnaida, 2018), and (Aniyati, 2019).

Learning with scientific-based learning scenarios are assessed by students as being able to increase activeness and interest in learning in finding solutions to problems, because scientific-based learning has a positive influence on students' ability to solve problems from the simplest events (Erny et al., 2017). Students also stated that the questioning activity made them more flexible in their opinion, this was because the opportunity to ask questions could familiarize students with expressing questions or thoughts during learning so that students' asking skills were better (Indriyanti et al., 2017). Students consider that discussions with teachers are carried out in almost every step of learning and trigger them to always think so that their thinking skills continue to be honed to foster students' critical thinking (Ilham & Hardiyanti, 2020) (Agustin, 2019).

The development of learning tools in the form of scientific-based learning scenarios that include observing, asking, trying, reasoning, and communicating activities can improve higher order thinking skills students' through increasing the average value of the experimental group which is higher than the control group, as in (Riadi & Retnawati, 2014) and (Purnaida, 2018) research. The use of scientific-based learning scenarios can be applied in learning activities to make it easier for teachers to present effective scientific steps to improve students' abilities, especially HOTS. HOTS can be achieved by students during communicative learning and familiarizes students to think starting from the simple things in class. HOTS is an ability at a high level for students so that educators should be capable to develop learning scenarios that are designed to enhance higher-order thinking skills.

The challenges of students in the future are much more complex than today, which requires teachers to have a heavier responsibility to prepare students. The research of (Nurhasanah & Yarmi, 2018)) and (Darmayanti, 2020), which discusses training or workshops to improve the ability of teachers in preparing scientific-based learning designs is one proof of the importance of learning changes made by teachers to the achievement of students' abilities in the future.

CONCLUSION

The results of this research and development apply the use of scientific components that have been developed as an effective step to optimize students' opportunities to get used to honing their thinking skills, especially HOTS. The scientific-based learning scenario includes scientific components that have been developed consisting of observing, asking, trying, reasoning, and communicating activities. "Observing" activities emphasize real objects to be presented to students, because real objects affect learning interest and can trigger students' ability to think critically. "Asking" activities are students' rights that arise from curiosity about the learning that occurs so teachers only play a role in providing stimulus with the aim that students can hone their questioning skills in each subject. "Trying" is an activity that focuses on enjoyable play activities to give students learning satisfaction using basic media so that teachers are not overburdened with presenting lessons. In order to keep students' interest in learning from waning, "reasoning" activities place a strong emphasis on connecting material to a single idea of knowledge. "Communicating" activities emphasize the habit of delivering information as a way for teachers to support students' learning processes, rather than whether or not the information that students have concluded is useful. As with HOTS, every scientific element generated aims to maximize the capacity for analysis, evaluation, and creation. The results of the effectiveness test show that H_0 is rejected, which means that there are also have differences between the experimental and control groups' students' average HOTS scores, where the experimental group has a better average score than the control group. Considering the test findings, It was reported that fourth-grade State Elementary School students' Higher Order Thinking Skills increased as a result of the scientific-based learning scenario.

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