Journal of Physics: Conference Series

PAPER • OPEN ACCESS

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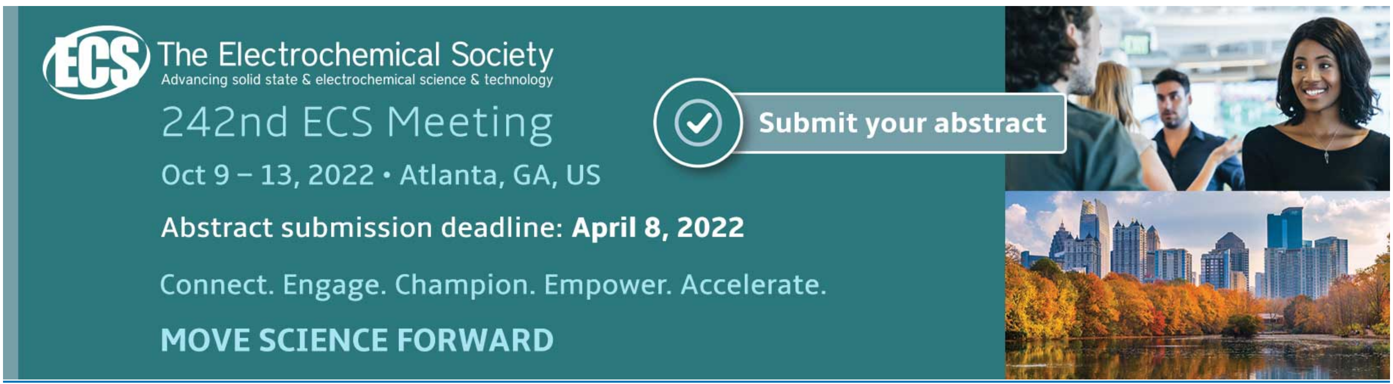
To cite this article: Fahmi *et al* 2021 *J. Phys.: Conf. Ser.* **2104** 012025



The practicality of natural science learning devices on the concept of environmental pollution with problem-solving learning models

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Abstract. Less varied learning methods make learning activities boring. Emphasis on mastery of concepts and teacher dominance make students' activities passive. The correct methods are needed to achieve the learning objectives. This study aims to evaluate the practicality of natural science learning devices for junior high school on the concept of environmental pollution using a problem-solving learning model. The research method uses Design Development Research by Tessmer. The data was taken at the small group evaluation and field test. Data were collected through observation of teacher and student activities with a scale of 1-4; self-assessment with a score of 1 (positive) and 0 (negative); and student response questionnaires on a scale of 1-5. The data were categorized and analysed descriptively. The results of the small group evaluation are: teacher activities get a good category; student activities with good categories in the preliminary and closing activities, but main activities are still quite good; self-assessment aspects show eight positive and two negatives, and student responses show nine positive and one negative. The field test results are: teacher and student activities get a "very good" category; self-assessment aspects show eight positive and two negative, and student responses are positive for all aspects.

1. Introduction

Learning is a process of interaction between students, educators, and learning resources. The general purpose of learning is to improve students' ability and increase the learning experience [1]. In addition, the learning environment also affects the success of learning, including the *IPA Terpadu* or Integrated

Science Learning. Integrated Science Learning based on Permendikbud Number 58 of 2014 is integrated science learning from the subjects of Biology, Physics, and Chemistry.

Science learning so far has not fully met expectations. Teachers carry out integrated science learning with more emphasis on mastering facts and concepts [2], using less varied learning methods [3][4], and teacher dominance in learning activities [5][6]. Limited time, facilities, a learning environment, and too many students per class are why science learning is carried out using memorizing concepts, theories, and laws. This reason indirectly causes students not to be accustomed to critical thinking [7]. As a result, students' interest in Integrated Science learning is low because it is considered that this lesson is boring.

In the PISA (Programme for International Student Assessment) study, Indonesian students' scientific ability in 2000, 2003, 2006, 2009, and 2012 has an average score of 393, 395, 395, 383, and 382 [8]. This result is below the international average score of 500, showing that the scientific ability of Indonesian students is still shallow and has only just arrived at the ability to recognize some basic facts and have not been able to communicate and relate these abilities in abstracts. Students are not trained to think critically and only memorize formulas compared to understanding concepts [9].

Critical thinking involves sorting out valuable ones from many ideas or making judgments before making decisions [10] [11]. There are five critical thinking indicators: identifying the problem, defining the problem clearly, exploring the problem and possible solutions, evaluating its application, and integrating understanding with existing knowledge [12]. In order to fulfill these critical thinking indicators, strategic learning planning is needed.

Experts in the World have developed and produced many learning strategies. This learning strategy aims to provide an alternative for educators to develop or improve students' problem-solving and thinking skills. One of the learning strategies in question is the Problem-solving Learning Model [13]. This learning model supports higher-order thinking activities, such as asking questions, finding problems, making hypotheses, planning investigations, expecting the desired results, conducting experiments, collecting and evaluating data, concluding, suggesting ideas, evaluating other ideas, and looking for alternative interpretations [14]. Learning with the problem-solving model occurs when students try to solve problems [15]. Skills in solving problems are done by proposing alternative solutions and testing their feasibility [11]. The ability to solve this problem includes understanding the problem, finding solutions, and communicating the results of the problem-solving experiment [16]. Students will always think critically and suggest ideas and solutions throughout the problem-solving process in learning activities with this model [17]. Learning activities using the Problem-solving Learning Model can be the right strategy applied to science subjects.

Not only critical thinking skills, but science learning also requires students to develop science process skills. This skill is essential for students to practice being honest, thorough, and process the information they have [18]. Science process skills consist of several activities, including observing, predicting, concluding, classifying, communicating, and measuring [19]. Science process skills include formulating problems, identifying variables, presenting data, analyzing data, formulating hypotheses, and conducting investigations or experiments [20][21].

Students need science to have critical thinking and problem-solving skills, become lifelong learners, and increase curiosity about the environment [17]. Environmental pollution is one of the main subjects in science subjects that are often discussed. This material is directly related to the current environmental issues. As in SMP Negeri 19 Banjarmasin, the lesson plans have not optimally implemented a problem-solving approach related to environmental issues. Analysis of the impact of learning activities on students' critical thinking skills is often overlooked.

The lesson plans need to be tested before being implemented, and the implementation results also need to be evaluated. In order to solve this problem, the researcher intends to develop learning devices that can improve critical thinking skills and scientific processes. The implication is that students can get used to suggesting ideas and solutions to environmental pollution problems.

2. Method

This study emphasizes the prototype phase of the development research design model. The research method uses a formative evaluation model from Tessmer. Tessmer's formative evaluation model consists of five steps: Self Evaluation, Expert Review, One-to-one Evaluation, Small Group Evaluation, and Field Test. The research is limited to the practicality test of the developed learning device [22].

The research was conducted at SMP Negeri 19 Banjarmasin. The students involved in the One-to-one Evaluation and Small Group Evaluation stages came from class VII C. Furthermore, the class used in the Field Test stage was Class VII A. The research subjects are described in table 1.

Table 1. Place of practicality in formative methods of evaluation

		Written Test-Based		Final Version	
		Expert Review (n=3)	One-to-one Evaluation (n=3)	Small Group Evaluation (n=5)	Field Test (n=30)
Practicality	Content		√wt	√to	√ft
	Interface		√wt	√to	√ft

Information:
*) = Content refers to the content of the support system
√ = primary attention of prototype and of formative evaluation Methods of formative evaluation: wt = walkthrough; ea = expert appraisal; ft = field trial; to = try-out

Practicality data were obtained from several instruments at several stages of formative evaluation, as shown in Table 1 above. The content practicality data was obtained at the One-to-one Evaluation stage using the students' readability instrument. The practicality of expectations is obtained at the Small Group Evaluation stage using the instrument of observing the implementation of learning devices, observing teacher activities, observing student activities, self-assessment, and student responses. Then, the actual practicality was obtained at the Field Test stage using the same instrument as the Small Group Evaluation stage.

Data analysis was carried out in several ways. The implementation data were analyzed using a Likert scale with a score of 1-4. The score for observing teacher and student activities uses an assessment rubric. The practicality analysis on the self-assessment questionnaire uses the Guttmann scale with a score of 1 if positive and 0 if negative. The analysis of practicality on students' questionnaire responses to learning activities was carried out using a Likert scale with a score of 1-5.

3. Results and Discussion

The product developed was an Integrated Science Learning device for the main subject of environmental pollution. The learning devices consisted of Syllabus, Material Analysis, Lesson Plans, Teaching Materials, Student Worksheets, and Assessment Sheets. The learning devices mentioned have gone through the Expert Review stage with valid results and can be used in the next stage, namely the practicality test.

The practicality of learning devices is divided into three: the content practicality, the expectations practicality, and the actual practicality, which are detailed as follows.

3.1 Content Practicality

The content practicality aspect seen from the user can easily understand the material presented [22]. The content practicality of the learning devices developed can be seen in table 2 and table 3. The content practicality includes the results of the student's readability test on teaching materials and Student Worksheets. The content practicality aims to review whether the content is easy to understand so that the implementation stage focuses on the use of the developed product.

Table 2. Assessment of teaching materials readability

No	Observed Aspects	Number of Students Assessing		Rating result
		Yes	Not	
1	Is the content of the teaching material interesting?	3	0	Interesting
2	Is the appearance of the teaching material attractive?	3	0	Interesting
3	The type of font used by comic sans	3	0	Interesting
4	Is the font size 12pt?	3	0	Interesting
5	The legibility and language used are appropriate for the age of the students	3	0	Already well
6	The terms used are precise and understandable	3	0	Already well
7	Use symbols and terms consistently	3	0	Already well
8	Use communicative language	3	0	Already well
9	Use effective language	3	0	Already well
10	In your opinion, is the description or explanation in this teaching material too difficult?	1	2	No

Table 3. Assessment of student worksheets readability

No	Observed Aspects	Number of Students Assessing		Rating Result
		Yes	Not	
1	Is the content of the Student Worksheets interesting?	3	0	Interesting
2	Is the appearance of the Student Worksheets attractive?	3	0	Interesting
3	The font type used by Book Antiqua	3	0	Already well
4	Is the font size 13 pt?	3	0	Already well
5	The legibility and language used are appropriate for the age of the students	3	0	Already well
6	The terms used are precise and understandable	3	0	Already well
7	Use symbols and terms consistently	3	0	Already well
8	Use communicative language	3	0	Already well
9	Use effective language	3	0	Already well
10	In your opinion, is the description or explanation in this Student Worksheets too difficult?	1	2	No

One-to-one evaluation of the developed learning devices, including teaching materials' readability and student worksheets, obtained a very good response. Sari has conducted a similar study about the content practicality of the science learning device for liquid materials to practice science process skills. The results of this study indicate that the learning devices developed are easy to use [23]. A similar study by Arsyad on the readability test of student worksheets shows that there are still tricky terms to understand, and it is necessary to choose more attractive images. The suggestions received at this stage have been improved [24]. Research on the development of high-level skills-based learning devices by Randa obtained an average readability response of students, namely practical [25].

3.2 Expectations Practicality

The expectations practicality includes the results of observing teacher activities, observing student activities, self-assessment by students, and student responses at the small group evaluation stage. This expectations practicality becomes the basis for determining whether the developed product can be continued at the field test stage. The expectation's practicality can be seen in table 4 to table 5.

Table 4. Observation of student activities at the small group evaluation stage

No	Activity types	Average Score Each Meeting				Average	Max Score	%	Category
		1	2	3	4				
1.	Preliminary	2	3	3	4	3	4	75	Good
2.	Main	2	2,3	2,5	2,8	2,4	4	60	Good Enough
3.	Closing	2	3	3	4	3	4	75	Good

The activities of students in small group evaluation in the preliminary and closing stages are in a good category, while the main stage for student activities are in the fairly good category. Meanwhile, student activities in main activities are still in a good enough category because students are still not used to using the problem-solving learning model. They must adjust first even though the teacher has been a good facilitator. These results need to be tested further through field tests.

Table 5. Student self-assessment at the small group evaluation stage

No	Observed Aspects	Score	%
1	I always work with friends in a group when doing group assignments	(+)	100
2	I record data carefully and according to facts	(+)	80
3	I perform tasks according to a predetermined schedule	(+)	80
4	I complete assignments based on various literature related to the subject matter being studied	(+)	100
5	I really like science lessons	(+)	100
6	I like science practicum activities	(+)	100
7	I always do my homework at home	(-)	40
8	I'm lazy to do my science homework	(+)	80
9	I have the ability to think critically	(+)	80
10	I have science process skills in learning science	(+)	80

Self-assessment at the Small Group Evaluation stage of ten aspects observed, nine aspects stated positive, and one aspect in number seven stated negative, namely the aspect of doing science homework at school. This aspect number seven obtained a negative value because only a small number of students did their homework at home according to the learning procedure. These results still need to be tested further through the field test stage.

Student responses at the Small Group Evaluation stage of the ten aspects observed: nine aspects state positive and one aspect in number four state negative. Although science learning devices can motivate students to think critically, students do not feel challenged to think critically in solving problems on the subject matter being taught. These results need to be tested further at the Field Test stage to determine their actual practicality.

3.3 Actual Practicality

Actual practicality can be seen in table 6 to table 7. Actual practicality includes the results of self-assessment by students and student responses at the Field Test stage.

Teachers and students have been able to carry out their roles very well so that learning goes as expected. In line with Sulistyanngkarti's research, students' involvement and mastery of concepts in the process of learning activities can be an indicator of learning success [26]. The results of observations by Tampubolon on the activities of teachers and students in implementing problem-based learning devices to improve problem-solving abilities of high school students obtained practical criteria. The results of this observation are considered a reference that the developed learning device can be continued on the effectiveness test [27].

Tabel 6. Student self-assessment at the field test stage

No	Observed Aspects	Score	%
1	I always work with friends in a group when doing group assignments	(+)	100
2	I record data carefully and according to facts	(+)	93
3	I perform tasks according to a predetermined schedule	(+)	100
4	I complete assignments based on various literature related to the subject matter being studied	(+)	90
5	I really like science lessons	(+)	100
6	I like science practicum activities	(+)	97
7	I always do my homework at home	(-)	30
8	I'm lazy to do my science homework	(-)	23
9	I have the ability to think critically	(+)	77
10	I have science process skills in learning science	(+)	90

Self-assessment at the Field Test stage of the ten aspects observed, eight aspects stated positive, and two aspects in numbers seven and eight stated negative, namely the aspects of doing homework at school and being lazy to do science homework. Suarta and Gusti agreed that students, through self-assessment, could see their strengths and weaknesses, and then the assessment results became an improvement goal [28][29].

Table 7. Student responses at the field test stage

No	Observed Aspects	%
1	Learning devices with the Problem-solving model can improve critical thinking skills, so I am very interested in learning about the subject matter of environmental pollution.	92
2	Learning devices with the Problem-solving model can improve science process skills, so that I enjoy learning the subject matter of environmental pollution.	91
3	Learning devices with Problem-solving models motivate me to improve critical thinking skills in studying the subject matter of environmental pollution.	89
4	Learning devices with the Problem-solving model challenged me to think critically in solving problems on the subject matter of environmental pollution.	94
5	Learning devices with the Problem-solving model can improve my scientific process skills to solve problems on the subject matter of environmental pollution.	92
6	Learning devices with the Problem-solving model, which involves practical activities and discussions, allows me to think critically in solving problems related to the subject matter of environmental pollution.	96
7	Learning devices with the Problem-solving model that involves practical activities and discussions allow me to improve science process skills in solving problems related to the subject matter of environmental pollution.	92
8	Learning activities in small groups on the Problem-solving model allow me to work together with friends in groups. They can improve my ability to think critically to solve problems related to the subject matter of environmental pollution.	92
9	Learning activities in small groups on the Problem-solving model allow me to work together with friends in groups. They can improve science process skills in solving problems related to the subject matter of environmental pollution.	92
10	Learning devices with the Problem-solving model can make me express ideas without any limitations so that it further enhances the critical thinking skills that I previously had.	94

Observation of student responses at the Field Test stage obtained positive results for all aspects. Problem-solving models influence positive student responses to improve critical thinking skills and science process skills. The feeling of being challenged to think critically initially received a negative response at the small group evaluation stage, but it received a positive response at this stage. In line with Hidjrawan's research, the response given by students to the problem-solving learning model is positive with good criteria [30]. Students' positive responses arise because they are given the freedom to be more active in asking questions, giving opinions, finding problems, analyzing, discussing, and solving problems independently [31][32].

4. Conclusion

Based on the results and discussion, the conclusions from the implementation of science learning devices, with the concept of environmental pollution, use the problem-solving learning model. The practicality of the contents of the one-to-one test results obtained very good criteria. The expectation practicality includes observing teacher and student activities as a whole obtained good criteria, although the main activities of student activities were still good enough. Nine out of ten aspects of self-assessment scored positive. Nine out of ten aspects of student responses received positive scores. The actual practicality includes the observation of teacher and student activities as a whole obtained very good criteria. Eight of the ten aspects of self-assessment scored positive. All aspects of student responses received positive scores. The results of each test show that the science learning devices developed are practical and can be continued in the effectiveness test.

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