

THE IMPROVEMENT OF STUDENTS' SCIENTIFIC LITERACY THROUGH GUIDED INQUIRY LEARNING MODEL ON FLUID DYNAMICS TOPIC

PENINGKATAN LITERASI SAINS PESERTA DIDIK MELALUI MODEL PEMBELAJARAN GUIDED INQUIRY PADA MATERI FLUIDA DINAMIS

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Abstract

This research was aimed to improve the students' scientific literacy through guided inquiry learning model on Fluid Dynamics material. The type of research was pre-experimental design with one group pre-test and post-test design that used 1 experimental class and 2 replication classes. The data analyzed was the learning implementation, scientific literacy aspects, and students' responses. The result of this research shows that: (1) the implementation of guided inquiry learning model to improve students' scientific literacy was done well and in accordance with the learning syntax; (2) there was an increase in the scientific literacy of high category in competency aspect that was in the competency to interpret data and scientific evidence. In addition, in the other aspects that were procedural knowledge aspect, local context aspect, and attitude of science interest aspect; and (3) the students' responses showed very good category. The implementation of guided inquiry learning model can increase students' scientific literacy level.

Keywords: Fluid Dynamics, guided inquiry learning model, students' scientific literacy

Abstract

Penelitian ini bertujuan untuk meningkatkan literasi sains peserta didik melalui model pembelajaran guided inquiry pada materi fluida dinamis. Jenis penelitian yang digunakan adalah pre-experimental design dengan menggunakan bentuk one grup pre-test dan post-test yaitu menggunakan 1 kelas eksperimen dan 2 kelas replikasi. Hasil data dianalisis keterlaksanaan pembelajaran, aspek literasi sains, dan respons peserta didik. Hasil penelitian menunjukkan bahwa: (1) keterlaksanaan model pembelajaran guided inquiry untuk meningkatkan literasi sains peserta didik terlaksana dengan baik dan sesuai dengan sintaks pembelajaran; (2) terjadi peningkatan literasi sains kategori tinggipada aspek kompetensi, yaitu pada kompetensi menafsirkan data dan bukti ilmiah. Selain itu pada aspek yang lain, yaitu aspek pengetahuan prosedural, aspek konteks lokal, dan aspek sikap minat terhadap ilmu pengetahuan; dan (3) respons peserta didik menunjukkan kategori baik sekali. Dengan demikian, penerapan model pembelajaran guided inquiry dapat meningkatkan literasi sains peserta didik.

Kata Kunci: *Fluida Dinamis, literasi sains peserta didik, model pembelajaran guided inquiry*

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I. INTRODUCTION

The 21st century is an era that has a strict competition in science. Good quality of human resources is required to face the competition. Education has an important role in preparing human resources [1]. That potency can be realized if the human resources, especially students have the ability to mastering science. Feni, et al [2] argued that the ability of students in mastering and studying science is closely related to the development of science and technology [2]. The rapid development of science and technology requires students to have good science literacy.

Literacy of science is very important for students to prepare their life in the globalization era today, with regard to understand the environment, health, economy, and other problems that occur in modern society. Students should be able to improve the competencies needed to meet the needs of their life in various situations. These competencies are expected to build themselves to learn more, and become useful for the surrounding community [3].

PISA defines science literacy as the capacity to use scientific knowledge and ability, identify questions and draw conclusions based on existing evidence and data in order to understand and assist researchers to make decisions about the world and human interaction with nature. Meanwhile, according to the National Science Teacher Association in Toharudin, et al, [3] a person who has science literacy is a person who uses the concept of science, has the scientific process skills to be able to judge in making everyday decisions when dealing with others, as well as

understand the interactions between science, technology and society, including social and economic development. Nbina [4] argues that science literacy can be obtained not only through school learning but also through interaction with objects and people in the surrounding environment, which involved in interaction and scientific activities.

PISA 2015 [5] built the science literacy category within the framework of science literacy design. The category includes four aspects: scientific competence, scientific knowledge, scientific context, and scientific attitude. The competence aspect is divided into three, namely explaining scientific phenomena, evaluating and designing scientific inquiry, and interpreting data and scientific evidence. The knowledge aspect is divided into three, namely content, procedural, and epistemic. The context aspect is divided into three, namely personal, local/national, and global. The attitude aspect is divided into three, namely interest in science, assessment of the scientific approach, and environmental awareness.

However, in fact Suciati et al [6] explained that the literacy ability of Indonesian students is low. This is known in the PISA 2012 report [5] where Indonesia was ranked 64 out of 65 participating countries. The factors that may affect the low literacy of science are the education system used today, the curriculum of learning, methods, and learning models. Therefore, the process of reforming and renewing the education in Indonesia should be done.

The scientific approach in the Curriculum 2013 includes science learning that involve students in conducting scientific investigations. The scientific approach means observing, asking, reasoning, trying, and communicating. Students are required to think critically, appropriately, analytically, and can solve problems. Then, the system which is used no longer the teacher center, but the student center. Science improvement and learning literacy with the curriculum 2013 can be well implemented if teacher can choose the right learning model. And, the appropriate learning model is the guided inquiry model. Guided inquiry-based learning is more effective in improving students' science literacy compared to traditional learning or lectures [7].

The guided inquiry learning model is a learning model that emphasizes the student's activity in looking for and finding information [8]. This learning model enables students to be learning subjects who discover concepts and knowledge by conducting independent discovery and inquiry processes, and providing a real and active learning experience for students in order to make decisions in solving an existing problem. By discovering these concepts and theories independently, learning will be more meaningful and stored in long-term memory. It is expected that with this guided inquiry model, students can play an active role in learning, while teachers become facilitators and motivators during the learning process. As a mentor of the thinking process, the teacher must also convey many questions [9]. Almutasherri, et al [10] also found that by using guided inquiry learning, teachers can use appropriate strategies to get students' understand to the concepts being taught.

Several previous studies supporting this research were done by Puspitasari [6],

Puspitasari found that guided inquiry-based learning was more effective in increasing students' science literacy compared to traditional learning or lectures. Ngertini, et al [1] obtained that the guided inquiry learning model is suitable as an alternative to science learning, especially in the achievement of understanding the concept and science literacy. Okada [11] obtained that the inquiry approach is a useful strategy to learn how science is developed, especially developing science literacy with the assistance of software media. Almutasherri [10] obtained that by using guided inquiry learning, teachers can use appropriate strategies to make students understand the concepts being taught. Odegaard [12] also obtained that literacy activities support students in exploring science issues, as well as engaging students to discuss each other.

Fluid Dynamics is a moving fluid or fluid that displaces its parts. The general characteristics of ideal fluids are the fluid's flow is steady, irrotational, incompressible, and non-viscous [13]. The Fluid Dynamics consists of streamline, flow tube, discharge, continuity equation, and Bernoulli equation. The streamline is the curve at which the tangent at each point is the direction of the fluid rate at that point. The flow tube is defined by the line of force forming the tube boundary. The discharge is the volume of a fluid that flows through a particular cross section and time. The continuity equation is the mass of the moving fluid that will not change as it flows. The Bernoulli equation is an equation that links pressure, flow rate, and altitude to flow and the ideal incompressible fluid. The Bernoulli equation states that the work performed by one volume unit in the fluid by the surrounding fluid is equal to the amount of change in kinetic energy and the potential energy of each unit volume that occur during the flow. Examples of applying Bernoulli

equations are Toricelli's Law, venturimeter, pitot tube, aircraft lift, spray perfume, and sailboats [14].

The purpose of this study is to describe the implementation of the guided inquiry learning model to increase the students' science literacy on the Fluid Dynamics material, to describe the improvement of science literacy of students after the application of guided inquiry learning model on Fluid Dynamics material, and to describe the response of students after the application of guided inquiry learning model to increase students' science literacy on Fluid Dynamics materials.

II. RESEARCH METHOD

Population in this research was 3 classes of student from XI grade. Each class consist of 35 students. The location of this study was at SMA Negeri 2 Bangkalan in the even semester of academic year 2016/2017.

The type of this research was pre-experimental design research method by using one group pre-test and post-test design. This design was developed by using one experimental class and two replication classes which have the same treatment that was by using the guided inquiry model to increase the science literacy.

The manipulation variable in this research was the guided inquiry model to increase science literacy. The responses variable in this research were the students' learning result in the improvement of science literacy. The control variable of this research were teacher, teaching material and time allocation.

The research instruments used were observation sheet, test sheet, and questionnaire. Observation sheet was used to find out that the instructional model of guided inquiry can increase the science literacy. The

test sheet was a cognitive pre-test and post-test scoring sheet used to measure the improvement of students' science literacy. The questionnaire was used to determine the students' response to learning outcomes by using the guided inquiry learning model to increase the science literacy. And analysis of research instrument used was the test of validity, reliability, level of difficulty, and the different power.

The first data analysis technique used was the analysis of learning implementation, the second was the test of requirements analysis by using the normality test, and homogeneity test, the third was the science literacy analysis by using paired t-test, the normalized gain, and the science literacy aspect, and the fourth was the students' response analysis.

III. RESULTS AND DISCUSSION

Learning Implementation Analysis

The implementation of the guided inquiry model learning is carried out in three different classes, the experimental class, the replication class 1, and the replication class 2. The three aspects observed are the learning implementation aspect in accordance with the syntax of guided inquiry instructional model, classroom aspect, and learning device aspect.

On the implementation aspect of learning there are three activities, namely introduction, core activities, and closing. In the core activities there are six phases of guided inquiry in relation to three science literacy competencies applied to students. At the initial activity, the teacher excavated early knowledge and motivated students by using a video phenomenon to know what material they are going to learn, and convey the learning goals.

In the core activities there are five phases. The first phase is presenting questions or problems.

In this phase, all three classes got 4.0 points with good categories and were in accordance with science literacy competencies where students are able to evaluate and design scientific inquiry with the indicator is identifying questions by searching in scientific learning. The second phase is making a hypothesis. In this phase, all three classes got 4.0 points with good category and were in accordance with the competence of science literacy where students are able to explain the scientific phenomenon with the indicator is proposing the hypothesis clearly. The third phase is designing experiments. In this phase, the experimental class got 3.7 points with good category, while for replication class 1 and replication 2 got 3.8 points with good category, and were in accordance with competence of science literacy where students are able to evaluate and design scientific investigation with the indicator is proposing how to investigate scientific questions.

The fourth phase is conducting experiment to obtain information. In this phase, all three classes got 4.0 points with good category, and were in accordance with science literacy competence where students are able to evaluate and design scientific inquiry with the indicator is explaining and evaluating various ways like scientists to ensure reliable data and objectivity. The fifth phase is collecting and analyzing data. In this phase, all three classes got 4.0 points with good category, and were in accordance with science literacy competence where students are able to interpret data and scientific evidence with the indicator is analyzing and interpreting data and drawing an appropriate conclusion. The sixth phase is to make a conclusion. In this phase, all three classes got 4.0 with good category, and were in accordance with science literacy competence where students are able to interpret data and scientific evidence with the

indicator is analyzing and interpreting data and drawing an appropriate conclusion.

The second aspect is the classroom atmosphere, where students and teachers were equally enthusiastic in following the learning. But for the appropriate time allocation, there was a little constraint. In the time management, teacher had difficulty because the time used was not optimal. Another obstacle faced was the experimental activities which was done by students took a long time because one of the experiment utilized the school field, so to set up the condition for students was quite complicated. But this guided inquiry learning model could build cooperation among students and build their thinking ability to find the concept that being taught. The experimental class got 3.6 points with good category, replication class 1 got 3.8 points, and replication class 2 got 3.6 points with good category. Therefore, the aspect of the classroom atmosphere has been done well.

The third aspect in the implementation of guided inquiry learning model is learning device, where the learning objective is suitable to be achieved with the teaching model which is being taught, the worksheet supports the achievement of the objectives, test and handout was used accordingly and reach the goal. The experimental class got 3.9 points with good category, replication class 1 and replication 2 got 4.0 points with good category. Therefore, the aspects of learning devices have been done well.

It was found that the average value of the learning implementation in the three classes is almost same. The experimental class showed the point of 3.81; the replication class 1 showed the point of 3.83; and the replication class 2 showed the point of 3.86. It was obtained that the total point of the three classes was 3.83 points, then it was obtained

that the implementation of guided inquiry model learning was in good category. Therefore, all the measured aspects have been implemented and achieved good results.

Science Literacy Analysis

Paired t-test

The paired t-test is used to determine the significance of differences in the results of students' science literacy skills before and after the implementation of the guided inquiry model. There is a significant difference of value if $t_{count} > t_{table}$ with significant level $\alpha = 0.05$. The t-test results is given in Table 1.

Table 1. t-test Result

Class	t_{count}	t_{table}	Information
Experiment	28.08		H_0 rejected
Replication 1	29.19	2.04	H_0 rejected
Replication 2	27.91		H_0 rejected

Based on Table 1, in the three classes is found that $t_{count} > t_{table}$, therefore $t_{count} > t_{table}$ then H_0 is rejected and H_1 is accepted, so it can be said there is difference of science literacy ability in three classes between before and after the application of guided inquiry learning model.

Table 2. Summary of Normalized Gain Analysis

Class	Criteria	Number of Students	Average of Gain $\langle g \rangle$
Experiment	Low	0	0.66
	Medium	23	
	High	12	
Replication 1	Low	0	0.72
	Medium	13	
	High	22	
Replication 2	Low	0	0.76
	Medium	11	
	High	24	

Normalized Gain

Normalized gain is used to determine the degree of influence from the guided inquiry learning model on the students' science

literacy by comparing the pre-test and post-test scores. There are 3 categories of gain scores, which are low in range $g < 0.3$, medium is in the range of $0.3 \leq g < 0.7$, and high within the range $g \geq 0.7$. The gain test results can be seen in Table 2.

Science Literacy Aspect

The science literacy aspect is used to measure the four aspects of science literacy, which are competence aspect, knowledge, context, and attitude aspects. Assessment of knowledge aspect, competence and context is observed from the cognitive assessment given to students in the form of pre-test and post-test, while for the assessment of attitude aspect is observed from the assessment of the students' response. The gain results of the four aspects can be seen in table 3, 4, 5, and 6.

The main aspect of science literacy is competence aspects which is divided into three parts, namely competence to explain scientific phenomena, competence to evaluate and design scientific inquiry, and competence to interpret data and scientific evidence. From the three aspects of competence, competence to explain scientific phenomena and interpret data and scientific evidence has an average gain with high criteria. Competence to explain scientific phenomena explains that the scientific phenomena are not merely about remembering, using theory, ideas, information, or facts, but explaining scientific phenomena means acknowledging, proposing, and evaluating explanations for various natural and technological phenomena. Therefore, if students are able to interpret data and scientific evidence, means they also can analyze and evaluate scientific information obtained. The competence of evaluating and designing scientific inquiry has an average gain of moderate criteria, in which students undertake a scientific inquiry and propose appropriate ways to handle scientific inquiry.

Table 3. The Result of Gain in Competency Aspect

Competency Aspect	Class	Criteria	Number of Students	Average of Gain
Explaining the Scientific Phenomena	Experiment	Low	0	0.71
		Medium	16	
		High	19	
	Replication 1	Low	0	0.78
		Medium	5	
		High	30	
Replication 2	Low	0	0.79	
	Medium	5		
	High	30		
Evaluating and Arranging Scientific Research	Experiment	Low	6	0.45
		Medium	25	
		High	4	
Scientific Research	Replication1	Low	6	0.48
		Medium	22	
		High	7	
	Replication 2	Low	8	0.55
		Medium	15	
		High	12	
Interpreting Data and Scientific Evidence	Experiment	Low	0	0.75
		Medium	9	
		High	26	
	Replication 1	Low	0	0.81
		Medium	4	
		High	31	
Replication 2	Low	0	0.86	
	Medium	0		
	High	35		

There are students who have high competence to explain scientific phenomenon, high competence to interpret data and scientific evidence, but the competence to evaluate and design the investigation is low. This is because the students are less able and less trained in designing scientific inquiry, and less communicative of the students' worksheet in the design of scientific inquiry so that it needs a little addressed. If students can interpret data and scientific evidence, then students will also be able to evaluate and design scientific inquiry and explain the scientific phenomenon

because of the concept that has been obtained from the interpretation of data and scientific evidence.

Table 4. The Result of Gain in Knowledge Aspect

Knowledge Aspect	Class	Criteria	Number of Students	Average of Gain
Content	Experiment	Low	0	0.73
		Medium	11	
		High	24	
	Replication 1	Low	0	0.72
		Medium	6	
		High	29	
Replication 2	Low	0	0.79	
	Medium	6		
	High	29		
Procedural	Experiment	Low	1	0.69
		Medium	14	
		High	20	
	Replication 1	Low	0	0.77
		Medium	8	
		High	27	
Replication 2	Low	0	0.83	
	Medium	0		
	High	35		
Epistemic	Experiment	Low	6	0.45
		Medium	25	
		High	4	
	Replication 1	Low	6	0.48
		Medium	22	
		High	7	
Replication 2	Low	8	0.55	
	Medium	16		
	High	11		

The second aspect of the knowledge aspect is divided into three parts, namely content knowledge, epistemic knowledge, and procedural knowledge. The three aspects of knowledge, content and procedural knowledge have an average gain with high criteria. The purpose of the content knowledge is to convey the idea that people must understand the concepts of existing science and apply them, in which the sciences are

related to one another. In this case, the students have been able to find scientific concepts sought by using the appropriate procedure of doing a scientific investigation. Epistemic knowledge has a moderate criterion, where students can build their own knowledge.

Table 5. The Result of Gain in Context Aspect

Context Aspect	Class	Criteria	Number of Students	Average Gain
Personal	Experiment	Low	0	0.63
		Medium	23	
		High	12	
	Replication 1	Low	0	0.67
		Medium	20	
		High	15	
	Replication 2	Low	2	0.75
		Medium	12	
		High	21	
Local	Experiment	Low	1	0.72
		Medium	12	
		High	22	
	Replication 1	Low	0	0.77
		Medium	3	
		High	32	
	Replication 2	Low	0	0.73
		Medium	4	
		High	31	
Global	Experiment	Low	1	0.69
		Medium	23	
		High	11	
	Replication	Low	2	0.71
		Medium	9	
		High	24	
	Replication 2	Low	0	0.78
		Medium	7	
		High	28	

There are students who have high content knowledge, high procedural knowledge, but low epistemic knowledge. This is because epistemic knowledge is more complicated than content and procedural knowledge, because epistemic knowledge is required to build their own knowledge. When students

master epistemic knowledge, they can provide reasonable procedures, structuring knowledge, and finding traits that serve as scientific guidance. The students who have high epistemic knowledge, will have high content and procedural knowledge as well.

The third aspect is the aspect of the context that is divided into three parts, namely personal context, local context, and global context. From the three aspects of context, local contexts have an average gain with high criteria because this context contains local issues that exist around the region or country demanding a growing understanding of science and technology. Okada [11] stated that the inquiry approach is a useful strategy to learn how science is developed so that students are able to explain the existing scientific phenomena, whether in a personal, local, or global context.

The fourth aspect is the attitude aspect that is divided into three parts, namely the attitude of science interest, the attitude of the assessment toward the scientific inquiry questions, and the attitude of environmental awareness. It was obtained, the highest attitudes of science literacy for the three classes was the attitude of interest to science that was 83.73, then the attitude of assessment toward the scientific inquiry questions was 82.29, and attitudes of environmental awareness was 83.21. It can be seen that students have a high sense of curiosity towards science.

It was obtained that the main aspects of science literacy was the competence aspect, the sub-competence to interpret data and scientific evidence in which students have to be able to analyze and evaluate the scientific information has the highest science literacy improvement, where students have to ask and give reasons in various opinions and draw conclusions. In addition, there was the lowest

aspect on the other aspect, which is epistemic knowledge. Students were still lacking in explaining examples such as differences in scientific theory and hypotheses, scientific facts and observations, and how to propose

ways to deal with scientific questions. Therefore, students should do more discovery and often be trained in discovery learning model, especially guided inquiry in order to handle these things

Table 6. The Result of Attitude Aspect

Attitude of Science Literacy	Experiment	Replication 1	Replication 2	Average
Interest in science	88.33	80.95	81.90	83.73
Evaluation on scientific inquiry questions	87.29	80.57	79.00	82.29
Environ-mental awareness	82.14	85.00	82.50	83.21

Based on the results of the normalized gain of pre-test and post-test from the three classes, namely the experimental class that was 0.66 with the criteria of medium increase on science literacy, the replication class 1 that was 0.72 with high increase on science literacy, and the replication class 2 that was 0.76 with high increase on science literacy. For each aspect of measured science literacy, it also experienced an increase with high average, where the competence aspects of interpreting data and scientific evidence, aspects of procedural knowledge, aspect of local context, and aspect of interest in science. It was obtained that guided inquiry learning model can increase students' science literacy. Therefore, there is compatibility between the results of research and theory that states guided inquiry model can provide opportunities for students to construct their own knowledge and develop science literacy. According to Puspitasari [7], guided inquiry learning is more effective in increasing students' science literacy compared to traditional learning or lectures.

Analysis of Students' Response

Student response analysis is used to determine the response of students after using guided inquiry learning model. If the percentage of students' response is high, then it shows a positive response to the teaching model.

The experiment class got an average response rate of 85.92% with very good criteria. The highest score is at number 2, where the students are happy to solve the problem through scientific investigation with guided inquiry learning model, because this learning model gives the student the opportunity to move forward according to his ability [15]. The replication class 1 got an average response rate of 81.00% with very good criteria. The highest score is at number 4, students discover that physics can help them to understand the surrounding environment and the current emerging technologies. Inquiry aims to develop students' logical, systematic, and critical thinking skills, and can develop intellectual ability as part of the mental process, so that it can help to understand the surrounding circumstances. The replication class 2 got an average response rate of 80.50% with good criteria. The highest score is at number 4, where students find that physics can help it to understand the surrounding environment and the current emerging technologies. This is the same as the first experiment class.

The average results of the students' responses in the three classes was 82.81% and was included in the excellent category. This suggested that students responded positively to the implementation of the guided inquiry

model because the guided inquiry model is suitable as an alternative to science learning, especially understanding concept and science literacy [1].

IV. CONCLUSION

Based on the results of research analysis and discussion, it can be concluded that the implementation of guided inquiry model to increase students' science literacy on Fluid Dynamics materials in the experimental class, replication class 1 and replication class 2 is well implemented and is in accordance with the learning syntax.

The implementation of guided inquiry model to increase the students' science literacy in Fluid Dynamics material enhance the science literacy in high category. Every aspect of science literacy measured also increased with high category, especially in main aspect that is competence aspect in competence to interpret data and scientific evidence. In addition, it was obtained the highest average score on other aspects, namely procedural knowledge aspect, local context aspect, and attitude of science interest aspect. After the application of guided inquiry learning, it was obtained students' responses with excellent category.

Based on the experience that had been done by the researcher during the research, the suggestion that can be given is, while using the guided inquiry learning model it is important to manage the time allocation as well as possible because this learning model takes a lot of time. Learning activity by using guided inquiry model should be done in physics laboratory or in the neighborhood around the school, not only stay in the class. It aims to increase the science literacy of students that is to read the circumstances of the environment so that become more easily to get information related to daily life. In order to increase scientific literacy, worksheet that

should be used is the science literacy worksheet and have to be made more communicative so that students can have better understanding on what they need and the science literacy will become more visible.

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