

Process skills approach to develop primary students' scientific literacy: A case study with low achieving students on water cycle

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1 Process skills approach to develop primary students' scientific literacy: *A case study with low achieving students on water cycle*

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Abstract: The results of the Program for International Student Assessment (PISA) study on the scientific literacy of Indonesian students since the year 2000 have been still far below the international average score of 500. This could also be seen from the results of the science literacy test of 5th-grade students of primary school in Indonesia which showed that 60% of students are still at level ≤ 3 (value < 500). The students' science literacy skills need to be improved by applying learning with a process skills approach. This study aims to describe the findings of classroom action research using a process skills approach to the science literacy level of primary students ($n = 23$). This research was conducted in 2 cycles with stages of planning, implementation, observation, and reflection. Students' ability in scientific literacy was measured by using description and subjective tests of context domains, knowledge, competencies, and attitudes. In this study, researchers found an improvement in students' science literacy skills when learning using a process skills approach. In addition, students' scientific attitude is also more positive. In activities for learning science, students should be challenged as often as possible so that they have more practice using their scientific knowledge and skills to solve problems presented by teachers in the classroom.

1. Introduction

Mastering literacy is important for all people in order to be able to compete in the global era both as members of society, citizens, and citizens of the world [1-3]. Every citizen has a scientific literacy ability which allows them to survive in the wild as well as in the workplace, with the knowledge, understanding, skills, and values that make up that competence. Literacy activities are more than just reading and writing, and include thinking skills using knowledge sources in print, digital, visual, and auditory [4].

Scientific literacy can be trained through studying. According to King, the purpose of teaching science is producing students who have competence in scientific literacy. The skills of teachers in planning the learning process is the key to successful learning [5]. One alternative way to improve literacy abilities of science students in the learning process is by applying the process skills approach. Scientific literacy can be enhanced through research-based learning, including *discovery learning* [6]. According to Rauf, et al, [7], process skills in science are very important in learning how to gain knowledge. Aktamis and Ergin [8] stated that process skills include the skills of each individual that are used in daily life which can improve the quality and standard of life by understanding the nature of science. Ango [9] stated that science process skills are basic and



essential components of the process of learning science under the guidance of a teacher. In line with this opinion, Ibrahim, et al., [10] stated that mastering process skills mean mastering skills to conduct research and solve problems. Problem-solving and research skills are life skills and are the highest learning outcomes for students.

This research aims to describe the level of scientific literacy of primary students in studying science with a process skills approach. The results of this research are expected to contribute to the improvement of science students' scores in scientific literacy in Indonesia conducted by PISA every 3 years. The results of the 2009 PISA study found that the average literacy score in science was 383, literacy in reading was 402 and literacy in math was 371 [11].

The results of research that have been conducted by Foulds and Rowe [12] show that when science teaching and increasing process skills are integrated into the learning activities of students, this can improve the students' understanding. Gormally, Cara., etc. [13] in their research found an increase in the scientific literacy of students using lab inquiry. The research of Sullivan [14] found that an understanding of environmental robotics with an open approach is able to encourage students to use scientific literacy and process skills as well as improving understanding. Remziye, et al [15] in their research found that learning by using inquiry approaches can improve process skills and attitudes about science.

Previous researchers, in their research on high school and college students, implemented inquiry-based activities which necessitate process skills to enhance understanding of what is being studied. In this study, researchers use a process skills approach to measure the scientific literacy intelligence of science students, in particular, primary school students. Scientific literacy includes context, knowledge, competence, and attitude, which can only be measured by testing high-level thinking ability. Scientific literacy is regarded as a key learning outcome in education for all students aged 15 years, regardless of whether they continue studying science or not, for participating in society [16]. Although not yet 15 years of age, primary students need to be introduced to scientific literacy in the context appropriate to their cognitive development, for example, their immediate environment and personal setting. The students who were the subjects of this research at a minimum had access to an on-site classroom and learning resources. In addition, their initial scientific literacy results were very low. Teaching that has occurred up until this point centered on the teacher and the students were not actively involved in the learning process. As a result, students are not used to using scientific knowledge through a series of scientific activities. In addition to this, measuring the students' knowledge was generally done focusing on memorized information, so only lower level knowledge was being measured.

The focus of this study is to describe the scientific literacy ability of science students learning about the water cycle. Basic competencies include describing the need for water-saving and describing the process of the water cycle and the way that human activities that may be affected. The scientific literacy indicators that were observed include identifying scientific issues, explaining phenomena scientifically and using scientific evidence.

2. Research method

This research is classroom action research with a descriptive, qualitative design, which aims to describe or reveal more deeply about the process and learning outcomes related to the scientific literacy level of primary school students. Before the action research began, students were given a pre-test and after the action research, they were given a post-test.

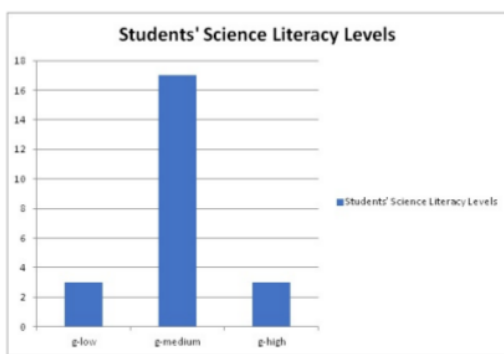
The subjects in this study were the 5th graders of Inpres Naikoten 1 Primary School, Kupang City, NTT Indonesia. There were a total of 23 students consisting of 12 boys and 11 girls studying water cycle. The subjects of the study were chosen after considering where the relevant needs were.

The research procedure included the planning phase, implementation, observation, and reflection. Instruments used in the research included scientific literacy tests, student activity observation sheets, and student science attitude questionnaires. Student activity observation sheets included formulating problems and hypotheses, using tools and materials as directed, observing,

analyzing data, and making conclusions. Student questionnaires were structured to determine students' opinions about vacant land empty of cultivated crops, excessive use of water, and so forth. The scientific literacy test was conducted twice; during the water cycle material and the material about the impact of human activities on the water cycle. The test was multiple choice. Here is an example of scientific literacy, which falls into the category of high-level thinking skills.

The multiple choice questions in each cycle were 10 questions; with 2 questions of level 1, 1 question of level 2, 2 questions of level 3, 1 question of level 4, 2 questions of level 5, and 2 questions of level 6. Before being used, the test was validated by 2 experts. The test was valid and needed only small revisions. The data about the scientific literacy level of students was analyzed descriptively. The indicators used to determine the success of this research was if there is an increase in the middle classification of scientific literacy level, 80% of students are able to answer questions at level 4 and the observation of scientific attitude reaches 80% (very good).

3. Results and Discussion



Data on the literacy test results in the areas of knowledge, context, and competency are presented as followed. It appears that students' science literacy ability in Cycle 1 learning is $52.17\% \leq$ level 3 and 47.83% are at level 4. None can reach level 6. After learning cycle 2, 8.70% students are ≤ 3 and as many as 91.30% are at level ≥ 4 .

Figure 1 shows the increase in students' science literacy levels in the range of $(g) > 0.7$ (g-high) scale of 3 people, $0.7 \geq (g) \geq 0.3$ (g-medium) of 17 people, $G) < 3$ (g-low) as many as 3 people. After applying the process skills

approach, there is an increase in scientific literacy skills from cycle 1 to cycle 2. This result shows that by undertaking process skills activities that are hands-on, it increased student learning outcomes. In process skills activities, students were directly involved in activities such as watching videos about the water cycle, asking questions, conducting activities as directed, discussing observations and making conclusions. By watching the video and asking some questions students will construct their own thoughts and discuss this with their peers. This is in accordance with the opinion of Semiawan, et al., [17] who explained that process skills are associated with the physical and mental skills needed for the fundamental abilities possessed, controlled and applied in scientific activity when scientists find a new discovery. Skills-based learning in the science process is learning that integrates the skills of the scientific process into a presentation of the materials in an integrated way. This learning emphasizes the process of seeking knowledge rather than the transfer of knowledge, learners are viewed as the learning subjects that need to be actively involved in the learning process, and the teacher is only a facilitator who guides and coordinates learning activities.

The above explanation is supported by the statement of Jerome Bruner and his colleagues who provide important theoretical support known as discovery learning, which emphasizes the importance of helping students acquire knowledge in a way that can train students' intellectual abilities, stimulate their curiosity and motivate their competence. This is what is meant by acquiring knowledge through discovery learning. In his book *Toward a Theory of Instruction*, Bruner points out "if we teach science, we will not produce small life libraries about science, but we want to make children think mathematically for themselves and participate in the process of acquiring knowledge. Knowing is a process, not a product" [18].

The result of an increase in student scientific literacy through applying the process skills approach shows the effectiveness of the approach used in teaching. Information submitted by teachers to students about learning materials related to the concept of water cycle and saving water

can be applied to daily life and students can draw conclusions from the problems provided by teachers. This is supported by Piaget's theory which explains that the main factor that encourages the cognitive development of a person is the motivation or power from within the individual himself to want to learn and interact with his environment [19]. Therefore, in order for students to be motivated to learn, teachers must be responsible for conducting interesting lessons, one of which is by applying the process skills approach in learning science. The results of the science literacy of the students in the domain of knowledge are in line with the results of the attitude domain which shows a positive attitude. The results of the attitude towards science domain are presented in Table 1 below.

Table 1. Scientific literacy attitude domain

No.	Statement	%	Category
1	Create wastewater storage at home	97	Very Good
2	Get drinking water as much as possible and not drink it until it runs out	100	Very Good
3	Be indifferent when I see the tap running in the school toilet	98	Very Good
4	Do not bury plastic waste in the soil	97	Very Good
5	Always promote a water-saving attitude to friends	99	Very Good
6	There are no restrictions on groundwater drilling by the government	95	Very Good
7	Provide suggestions to parents to create a rain water catchment basin	97	Very Good
8	I chose to take a bath from the tub with a dipper rather than with a shower	100	Very Good
9	The government establishes a program of absorbing wells at several points of the city	96	Very Good
10	Turn off the water tap during brushing and washing hands	100	Very Good

Scientific literacy in the domain of science attitudes became very good in relation to their responses about wastewater capture, taking drinking water, not burying plastic rubbish, and so on. The results from this attitude domain can reawaken the active role of the students to acquire concepts from the learning activities, then the students can apply the concepts obtained to everyday life. This explanation is supported by Piaget's theory that the child builds his own knowledge from his own experience within his environment. In Piaget's view, knowledge comes from action, and cognitive development largely depends on how far children are actively manipulating and actively interacting with their environment. The tendency of primary school children is to move from the concrete things, and then look at needs in an integrated way. Based on the above trends then, learning is an active process, constructive, and goal-oriented, all of which depends on the mental activity of learners. The provision of direct learning experiences in science lessons is strongly emphasized through the use and development of process skills and scientific attitudes with a view to understanding concepts and solving problems [21]. This is in accordance with the student's activity observation results in Table 2.

Table 2. Student activity in classroom learning

No.	Student Activity	Percentage (%)
1.	Formulate questions	100
2.	Make a hypothesis	89
3.	Using tools and materials according to instructions	100
4.	Cooperate in the activities of observation	87
5.	Discuss and analyze the observation data	98
6.	Discussion to summarize	89

Based on Table 2 above, students were involved in scientific investigation activities $\geq 80\%$. The process skills approach integrated into science lessons can actively involve students in the learning process [17], as well as strengthening the revelation of Dimiyati and Mudjiono [20] on the advantages of science process skills. Providing opportunities for students to work with science, rather than just telling or listening to stories about science, can lead to more active students, as well as science process skills that can help students learn scientific processes and knowledge at the same time.

High student activity in this study is supported by several theories, such as Piaget, who states that learning is an active process, constructive, goal-oriented, and learning all depends on the mental activity of learner [21]. Bruner also revealed that discovery learning is the foundation of the discipline of science, the need for the active involvement of students in the learning process, and he believes that this actually takes place through personal discovery. The goal of education not only trains the knowledge base but also creates opportunities for students' invention and creativity [22]. Bruner suggests that students should learn through active participation with concepts and principles in order for them to gain experience, and conduct experiments that allow them to discover the principles themselves [23].

Jerome Bruner is a Harvard psychologist who provides important theoretical support for discovery learning, an instructional model that emphasizes the importance of helping students to understand the structure or key ideas of a discipline, the active involvement of students in the learning process and the belief that true learning takes place through personal discovery. Discovery learning emphasizes the inductive reasoning and investigation processes that characterize the scientific method [24].

The most visible and influential student activity is the discussion between peers and teachers. This is in line with what described by Vygotsky's theory which states that if children work or handle tasks that cannot be solved on their own, then they can be solved with the help of peers or adults.

4. Summary

There is an increase in students' scientific literacy levels after they engage in lessons using the process skills approach. This happens because in the learning process the students are actively involved in learning both physically and mentally (hands-on activity) through observing activities, making inquiries, conducting activities as directed, analyzing data, and drawing conclusions. The students' scientific attitude also experiences positive development. This shows that the ability of scientific literacy can be increased through learning activities.

In order to increase scientific literacy, it is best if classroom learning is designed to be problem-solving and challenging to students. To present problems in the classroom, the teacher can present phenomenon from the surrounding the environment in the form of video or live activities, demonstration, and storytelling related to the topic being studied.

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