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An Analysis on Students Problem-Solving Skill and Scientific Literacy Based on Higher Order Thinking Skills (HOTS) Viewed from Gender

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Abstract: Each student has differences in problem-solving, scientific literacy, and higher-order thinking skills. Gender differences partially influence student mindset. The purpose of this study was to analyze the problem-solving skill and scientific literation of students on different genders. The study adopted and modified the one-shot case study design. The subjects of this study were 76 students who took the Animal Ecology course. Both experimental classes were given treatment using practical activities. Data on students' problem-solving skill were collected by using a test consisting of 25 questions. Whereas scientific literacy was collected by using essay questions. Students' scientific literacy were categorized into 5 scales that were analyzed by using percentages. Statistical analysis uses descriptive and t-tests to determine differences in problem solving skill on different genders. The results showed that (1) 37.66% of students' scientific literacy are on a multidimensional and conceptual scale, while the remaining 62.34% were on a functional, nominal and literacy scale, (2) students' problem-solving skill are in the medium category, and there is no difference in problem-solving skill in males and females (p>.05).

Keywords: HOTS; Scientific literacy; Problem-solving skill; Gender

Introduction

There are two levels of thinking, namely (1) Low Order Thinking Skills and (2) Higher Order Thinking Skills (HOTS) (Mohamed & Lebar, 2017). HOTS is defined as the ability to think critically, logically, reflectively, metacognitively, and creatively (King et al., 2012). HOTS includes levels of analysis, synthesis, and evaluation (Brookhart, 2010) which are part of the revision of Bloom's taxonomy (Fanani, 2018) as well as cognitive mastery in applying routine things in new and different situations (McDavitt, 1994; Dinni, 2018). HOTS is divided into three categories, i.e. the transfer of information or knowledge, critical thinking, and problem-solving (Brookhart, 2010). Information or knowledge transfer is the ability to connect with other people who are not familiar with the situation; critical thinking skills related to the ability to understand logic problems, reflective thinking skills and the ability to debate which can be focused on making decisions or doing something; while the ability to solve problems related to the ability to find new ways, solutions that are not common, and define problems creatively (Widana, 2017).

The ability to solve problems is one of the skills that students must have in the 21st century (Redhana, 2019). Problem-solving skills related to the ability to search, choose, evaluate, organize, and consider various alternatives and interpret information (Zubaidah, 2016). Problem-solving skill is important to improve the quality of human resources (Cahyani & Setyawati, 2017). Problem-solving skill benefit students by helping students' solve problems of daily life and develop themselves (Mulyati, 2016); improve students' understanding of the material and relate it to real-life; and improve students' analytical and synthesis skills

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(Murdiana, 2015). The ability to understand lessons and implement them in problem-solving in real life is one indicator of learning success. Therefore, to improve the skill of problem-solving as one of the successes of learning, scientific literacy is needed. Literacy is very important for students to apply their knowledge to solve problems in daily life for personal, social and global needs (Schleicher et al., 2009). Besides, scientific literacy is an indicator of the quality of education and human resources of a country (Winata, 2018).

Science literacy is the use of scientific knowledge to identify questions, obtain new knowledge, explain scientific phenomena, and draw a conclusion based on evidence about issues related to science (OECD, 2013). Science literacy includes an understanding and knowledge of science, scientific processes, and the development of scientific attitudes that are used to solve various problems and make decisions based on scientific considerations (Yuliati, 2017). Science literacy is also defined as the use of scientific knowledge and its applications in society. Science literacy is important for society because of many problems in society related to science and technology (Mahardika et al., 2016).

The results of preliminary studies reveal that the ability of scientific literacy is influenced by higher-order thinking skills (Rahayuni, 2016; Cahyana et al., 2017; Susiati et al., 2018). The results of the study revealed that there was linearity between higher-order thinking skills and scientific literacy abilities. However, not many types of research have revealed how HOTS-based questions can measure scientific literacy and student problem-solving skill using the same instrument. Besides, there is still little research that reveals the impact of HOTS on problem-solving skill and scientific literacy in different genders. This research will strengthen previous research and also as a new reference on how to develop HOTS-based questions to measure the scientific literacy and problem-solving skill of students on different genders.

Methods

This study adopted and modified the one-shot case study design (Campbell & Stanley, 2015). The subjects of this study were sixth-semester Biology Education students who were taking Animal Ecology courses at the Faculty of Teacher Training and Education, University of Mataram, with a total of 76 people. Two selected experimental classes selected randomly were treated using practicum activities. The next two classes were given HOTS questions in the form of essays to measure the literacy of students who amounted to 3 questions and multiple-choice questions to measure the problem-solving skill of students which totaled 25 questions. All data collection instruments were validated by material experts and evaluation experts. Material experts are lecturers who teach Animal Ecology lectures, while evaluation experts are lecturers who teach learning evaluation lectures. The scientific literacy ability that was analyzed was the ability of students' biological literacy which was categorized into 5 scales, namely multidimensional, conceptual, functional, nominal and literacy (Mahardika et al., 2016). Data on students' biological literacy abilities were analyzed using descriptive statistics (McCluskey & Lalkhen, 2007), while problem-solving ability data was converted into nominal data which was further analyzed using an independent sample t-test (Gerald, 2018) to determine differences in problem-solving skill in males and females' students.

Results and Discussion

To determine the ability of student literacy, an analysis of student answers was conducted which were categorized into 5 literacy scales, namely multidimensional, conceptual, functional, nominal and literacy. The results of the biology literacy analysis of students are shown in Figure 1.

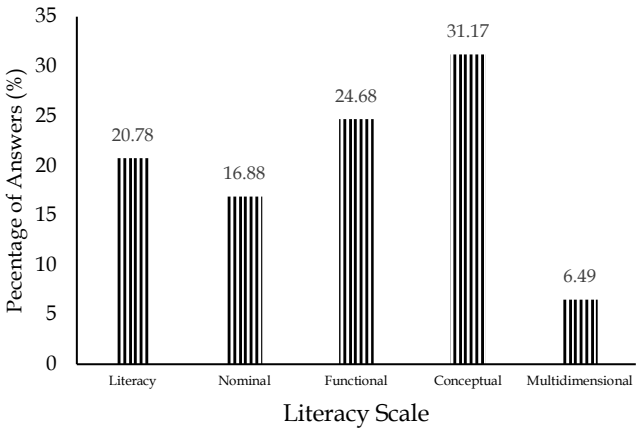

Figure 1. The results of student biology literacy analysis

The results of the analysis in Figure 1 show that as many as 6.49% of students have a multidimensional literacy scale and 31.17% have a conceptual literacy. Multidimensional literacy refers to answers that combine a scientific understanding of various disciplines using scientific investigation procedures. Besides, answers develop some understanding and relate it to everyday life. Whereas conceptual literacy leads to answers that develop conceptual understanding and relate it to students' understanding of science and demonstrate procedural abilities and scientific processes (Mahardika, Suwono and Indriwati, 2016). When referring to Bloom's taxonomic cognitive level, multidimensional and conceptual literacy leads to the level of evaluation and creation. Therefore, the two scientific literacies are analogous to the ability to think at a higher level at levels C5 and C6.

Based on the results in Figure 1 it was also revealed that few of the students had multidimensional and conceptual literacy compared to the other three literacy scales. The percentage of students who have multidimensional and conceptual literacy is 37.66%, while the remaining 62.34% of students are on the functional, nominal and literacy scales. Seeing this result, it was revealed that only 37.66% of students could solve HOTS questions and the majority of students could not work on the HOTS questions that were given. The low number of students who have multidimensional and conceptual literacy is likely due to several factors, namely (1) the initial ability of students in the Animal Ecology course is low. This is reinforced by classroom observation activities which showed that mastery of Animal Ecology material by students is still low. This has also been reported by Hanafi & Wulandari (2019) who revealed that early understanding affects students' abilities in solving HOTS questions; and (2) students have never been trained to use higher-order thinking skills so that when given HOTS questions, students have difficulty in solving the given questions. This is reinforced based on the results of interviews with students who revealed that the Animal Ecology course was the first course to initiate the training of high-level thinking skills to students. This is supported by Angraini's research (Angraini, 2014) which found that the factor of habituation or training by the teacher in the learning process affects the results of students' scientific literacy.

Based on the results of this study it is known that the HOTS questions given can reveal the literacy abilities of students especially biology literacy. This is because the HOTS questions that have been prepared have special characteristics so that they can measure the scientific literacy of students, namely (1) HOTS questions that are developed based on contextual issues. This is important because the ability of scientific literacy is related to the ability to solve problems in daily life (OECD, 2013), so HOTS questions that are developed must be able to reveal the problem-solving skill of students. This is in accordance with the opinion of Fanani [4] which states that HOTS questions must be able to uncover contextual problems and be able to connect, interpret, and integrate knowledge in classroom learning to solve problems in real contexts; (2) HOTS questions are developed to ask students to think critically through a process of analysis, reflection, and giving arguments to each of their answers, so that each student's answer is a picture of critical thinking skills as well as a description of their literacy abilities. This is reinforced by the results of previous studies which found that critical thinking skills can affect the ability of scientific literacy (Cahyana, Kadir and Gherardini, 2017). Both of these characteristics are believed to be the cause of the ability of HOTS questions to reveal the ability of students' scientific literacy.

To determine students 'problem-solving skill, an independent sample t-test was analyzed to determine differences in students' problem-solving skill based on gender. Before the independent sample t-test was performed, a prerequisite analysis is carried out to determine the homogeneity and normality of the data. The results of homogeneity and normality data analysis are shown in Tables 1 and 2.

Table 1. Data normality test results

Variable	Gender	Kolmogorov-Smirnov		
		statistic	df	sig
Problem-solving ability	Male	.119	13	.200
	Female	.111	63	.053

Table 2. Homogenitas varians test result

		Levene statistic	df	sig
Student's Problem-solving ability	Based on Mean	.026	74	.873
	Based on Median	.037	74	.848
	Based on Median and with adjusted df	.037	43.602	.848
	Based on trimmed mean	.026	74	.871

Tabel 3. Independent sample t-test result

Variable	Levene's Test for Equality of Variances		t-test for Equality of Means				
Problem-solving ability	F	Sig.	t	Df	Mean Difference	Std. Error Difference	Sig (2-tailed)
	.026	.873	-1.085	74	-4.05372	3.73737	.282

The results of the analysis of data normality in Table 1 show that the probability value (p) is greater than .05 for both males and females. Therefore, the data on students' problem-solving skill is normally distributed. While the results of the homogeneity analysis show that the probability value (p) is also greater than 0.05 (Table 2). Based on the results obtained, the data has a homogeneous variance. After conducting the next prerequisite test, an independent sample t-test was conducted to determine differences in students' problem-solving skill in different genders. The results of independent sample t-test analysis are shown in Table 3. The analysis results in Table 3 show that the probability value is greater than .05 (p = .873> .05). This revealed that there was no difference in problem-solving skill in male and female students. These results reinforce

previous studies which revealed that there were no differences in ability between male and female students in solving mathematical problems (Indrawati & Tasni, 2016), addition female and male subjects were able to solve problems in either category (Nur & Palobo, 2018). The results of descriptive analysis of problem-solving skill in male and female students revealed that the average value of problem-solving skill in females was 43.25, while in males was 47.31 and both were included in the moderate category (Romika, 2019). This lack of problem-solving skill is suspected because students are less accustomed to being trained to solve problems based on HOTS and based on problem-solving (Anisah & Lastuti, 2018). This research has a weakness, namely, the number of samples is still small, especially for the number of male student samples, so it is necessary to do further research with a larger sample size to get better results.

Conclusion

The results of this study indicate that HOTS questions can reveal literacy abilities and students' problem-solving skill. Furthermore, it is known that 37.66% of student literacy skills are on a multidimensional and conceptual scale, while the remaining 62.34% is on a functional, nominal and literacy scale. The results of the analysis of problem-solving skill show that the problem-solving skill of students are in the medium category, and there are no differences in problem-solving skill in males and females.

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