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Improving Higher-Order Thinking Skills-based Science Literacy Questions in Science Learning Using Reading to Learn Model

Aperius Lahagu[1], Agnes Renostini Harefa[2], Novelina Andriani Zega[3], Hardikupatu Gulo[4]
[1, 2, 3, 4] Department of Biology Education, Universitas Nias, Indonesia

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ABSTRACT
Science literacy is important for everyone to have a greater opportunity to adapt in life, especially in terms of mastering reading skills to improve a country's development. The aim of this study was to describe the improvement of science literacy using HOTS questions by applying the R2L model to science learning materials. This research is quasi-experimental research with one group pretest-posttest design conducted in SMP Negeri 1 Mandrehe Utara. The results of this study showed that there was an increase from the average score of 68.48 (sufficient category) to 83.75 (very good category) and obtained an N-Gain value of 0.42 on moderate criteria. Science competence in explaining phenomena scientifically increased by 16.02, the competence of evaluating and designing scientific investigations increased by 13.54, and the competence of interpreting data and evidence scientifically increased by 16.67 and this competency is the competency that has the highest increase. The application of the R2L model using HOTS questions has given teachers the flexibility to adjust reading materials based on the abilities of students and the situation of science learning so that the improvement of science literacy can be realized.

Corresponding Author:
Aperius Lahagu
Department of Biology Education, Universitas Nias
Jalan Yos Sudarso No. 118/E-S, Gunungsitoli 22812, Indonesia
Email: apelahagu@gmail.com

1. INTRODUCTION

Global change is felt so rapidly entering the 21st century that it has an impact on all sectors of development, including the education sector. In the 21st century, Indonesia is getting ready to welcome a promising era by producing students who are in accordance with the demands of the times. This goal can be achieved through education and appropriate learning approaches, strategies, and models, all under the guidance and role of the teacher during the learning process (Dilekçi & Karatay, 2023; Gunadi et al., 2022). Education is a benchmark in determining the progress of a nation. Education today encourages the younger generation to develop their potential by continuing to innovate and work in order to survive in the face of global competition. Education prepares qualified learners who have an awareness of knowledge, values, skills and attitudes (Meyer & Norman, 2020). One of the things that must be done is to develop potential through the field of education. Science is needed in everyday life to fulfill human needs by solving problems that can be identified. Contextual problems related to daily life related to scientific fields can be explained and solved if people have good science literacy.

Science has a great influence on people's personal lives and the global economy. Science is essential for developing the quality of human resources (Li & Guo, 2021). To be successful in this century, learners must have good science literacy and principles for lifelong learning (Fortus et al., 2022; Purnawati, 2024) and thinking skills (Arifiyyati et al., 2023; Putranta & Supahar, 2019). Science literacy is a scientific knowledge and skills that can be used to make decisions based on scientific facts, research, and phenomena (Harefa & Huang, 2023; Kalkan et al., 2020; Virtič, 2022).

Science literacy was accommodated in the 2006 KTSP and is clearly visible in the 2013 Curriculum through inquiry activities and a scientific approach as well as in the Merdeka Curriculum emphasizing elements of contextual learning outcomes. literacy is important for everyone to have a greater opportunity to adapt in life, especially in terms of mastering reading skills in order to improve the development of a country. The implementation of science content learning at the junior high school (SMP) level is focused on natural science (IPA) subjects. Teaching in science subjects in junior high school must provide direct experience through

observation activities using the senses owned by students and a concrete information transfer process for students. Moreover, science learning is packaged in thematic form, meaning that there is no separation of biology, physics, and chemistry subjects (Lestari et al., 2022). Science learning is carried out in an integrated manner in which the material presented is associated with other concepts through the analysis of the results of a learning plan. Strat et al. (2024) and Wang et al. (2024) suggested that to make learners aware of science content, learners must be assisted through mentoring or collaboration. The practical solution that can be done by teachers in maximizing the process of transferring science content information is to integrate science literacy in every science learning process.

Based on the results of the Program for International Student Assessment (PISA), it shows that the science literacy score of Indonesian students in PISA 2018 was 396 and decreased to 383 in PISA 2022 . Moreover, the average science score from the OECD test results was 485 and this result indicates that Indonesian students' mastery of scientific literacy is still far below the average (OECD, 2023). One of the causes of this decline is due to the lack of a learning process that provides problem-solving or is only limited to theory so that when given real problems, students will have difficulty thinking logically (Amini & Sinaga, 2021; Harefa & Gulo, 2024). The low science literacy of students is evidenced by the results of several scientific studies. The lack of teacher creativity in providing aspects of science materials and science processes in the learning process in the form of factual texts causes students to only memorize or without understanding a concept. Furthermore, Laslo & Baram-Tsabari (2021) explained that the target of science learning is to get high or good school exam scores, not because students feel that science learning needs to be learned to be able to deal with problems in everyday life. Science learning patterns that do not change or only target improving exam results make students' science literacy skills low.

Science literacy is a person's skill to use scientific concepts to apply them in life, explain scientific phenomena and describe them based on scientific evidence. Science literacy is very important in solving problems related to knowledge. Previous research revealed that reading activities can develop students' science literacy skills. A study showed that reading is one of the effective ways to maintain learners' epistemic insight, which is the core of scientific literacy (Ding, 2022; Lawless et al., 2018). However, literacy skills are not only reading and writing, but linking thinking skills to form literate learners in science learning. Reading skills are not just reading and writing, but connecting thinking skills to become a smart generation in science learning or better known as higher-order thinking skills (HOTS) (Virtič, 2022).

Reading skills are a means to assist scientific steps to obtain scientific truth. By thinking scientifically, learners can gain the ability to investigate scientifically well, systematically and carefully. Reading skills are a strong reason to improve learners' literacy skills, it also leads to skills in mastering data, analyzing, critical vulnerability, and reflective (Hamilton & Hayiou-Thomas, 2022). Learners' science literacy skills can be improved in the right way and supported by adequate technology. The meaning of literacy in the field of science is the ability of students to understand, be able to think, and be able to apply scientific perspectives, and be able to apply concepts in their lives. Research results from Fariyani & Kusuma (2021) and Takko et al. (2020) stated that high-level thinking skills (HOTS) through understanding science processes and skills will influence decision making to participate in the context of life concerning economic and cultural aspects. The use of science in identifying and proving facts when interpreting the universe with human events is what PISA expects. Learners not only master knowledge but can use it in the dimensions of social life, issues, and cultural changes in the scientific community. But in reality, the science learning process so far has not integrated science literacy that can increase students' higher order thinking skills (HOTS) (Widyaningrum et al., 2021).

PISA defines four dimensions of science literacy, namely 1) the content dimension (science knowledge), 2) the process dimension (science competence), 3) the context dimension (science application), and 4) the dimension of students' attitudes towards science (Costa et al., 2021). The four dimensions of science literacy must be considered by teachers in implementing literacy-based science learning so that students' literacy skills can develop optimally. Meanwhile, PISA emphasizes the achievement of three literacy competencies, namely explaining phenomena scientifically, evaluating and designing scientific investigations, and interpreting data and evidence scientifically (OECD, 2023). Learners' understanding of the material taught is often hampered because the models and media chosen are not appropriate. As a result, students receive more information delivered by the teacher, with minimal active involvement in the learning process. The learning model plays an important role as a successful supporting medium to train students' skills in learning activities. The right model is needed and in accordance with the objectives to train students' science literacy and literacy competencies in science learning.

The reading to learn (R2L) model is one model that can help learners become more proficient readers and writers. The R2L model is a set of strategies designed to improve learners' literacy competencies through reading and writing activities. The R2L model invites learners to read and interpret reading texts. The reading text used in the R2L model has criteria that must be met, namely the reading text must be in accordance with the material to be studied, the language and sentences in the text must be arranged and adapted to the average age/ability of the learners, and the reading text must be able to make learners optimize their reading ability (Husein et al., 2022; T. Lestari et al., 2022). Based on the results of this problem analysis, the purpose of this study is to describe the improvement of science literacy using HOTS questions by applying the R2L model to science learning materials.

As previously described, science literacy is a high-level thinking process (HOTS) that refers to a person's ability to relate one science concept to another, process and apply information, seek information from different reference points, use the information to solve problems, and analyze information critically. The integration of HOTS questions in the science learning process will provide a maximum description of the improvement of science literacy skills after applying the R2L model.

2. RESEARCH METHOD

This research is a quasi-experimental research with a one group pretest-posttest design (Creswell, 2017). This research was conducted at SMP Negeri 1 Mandrehe Utara. The technique used in this sampling was the total sampling technique, which is used when all members of population are used as sample (Creswell, 2017) so that 32 ninth grade students were obtained. The research instrument used was 20 science literacy HOTS questions that had been tested using the item instrument test. Science learning materials vary greatly so that to conduct this research, researchers chose ecosystem material and this material contains more reading material so it is suitable for use in investigating the application of the R2L learning model. The questions were made based on the indicators of students' science literacy which include aspects of three competencies, namely explaining phenomena scientifically, evaluating and designing scientific investigations, and interpreting data and evidence scientifically. Data obtained through tests given before (pre-test) and after implementation (post-test). Researchers can determine the science literacy skills of students based on pretest and posttest scores and describe the effect of the R2L learning model. The test results were analyzed using the percentage formula with the adjustment of HOTS score as shown in Table 1 (Yin & Samat, 2023). Data will be processed through the Microsoft Excel program and SPSS version 25 to process and present research results in the form of tables and figures.

Table 1. The category of HOTS level with score.

Score	Level
80-100	Very good
70-79	Good
60-69	Sufficient
40-59	Bad
0-39	Very Bad

3. RESULT AND DISCUSSION

This study analyzes the science literacy skills of class IX students of SMP Negeri 1 Mandrehe Utara in science learning with the selected topic of ecosystem. This study used 20 multiple-choice questions that had passed the item instrument test. The Shapiro-Wilk normality test presented in Table 2 shows that the value of Sig. > 0.05 so it can be stated that the research data is normally distributed. Based on the results of statistical analysis, it was found that the value of Sig. (based on mean) of 0.132 and the results of this value are greater th an 0.05 so it can be stated that the samples used during the pre-test and posttest came from a population that has the same variance.

Table 2. Shapiro-Wilk normality test results

Assessment	Statistic	df	Sig.
Pre-test	0.965	32	0.365
Post-test	0.958	32	0240

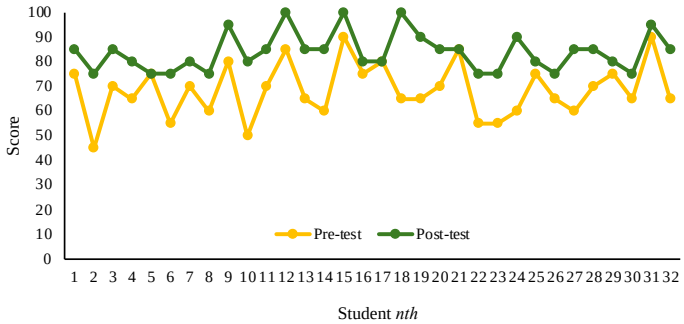

Figure 1. The result of students' pre-test and post-test.

Before the implementation of the model, students were given a pre-test to obtain information on the level of science literacy skills using HOTS questions. Based on the pre-test results presented in Figure 1, it shows that the highest score, lowest score, and average score are 90.00, 45.00, and 68.91, respectively. The standard deviation of the pre-test results is 12.04, which shows that there is a tendency for mastery of knowledge to vary greatly

among students. The pre-test results also show the division of HOTS question processing categories where as many as 21.88% of students are in the excellent category, 28.12% of students are in the good category, 34.38% are in the fair category, and 15.62% are in the poor category. The findings of this study also emphasize the results of PISA 2022 which show that the achievement of science literacy achieved by Indonesian students is getting lower. In general, the ability of Indonesian students is very low in integrating information, generalizing case by case into general solutions, formulating real-world problems into science subject concepts and conducting investigations (Herlina & Abidin, 2024). After the data obtained from the pre-test results, the researchers provided treatment in the form of learning with the literacy-HOTS-based R2L model to determine whether there was an increase in science literacy skills after treatment. Figure 1 also shows that the implementation of the post-test obtained the highest value, lowest value, and average value are 100.00, 75.00, and 83.75, respectively. The standard deviation of the post-test results is 6.14 with a decrease of 4.42 from the pre-test which shows that there is a significant effect after the application of the R2L model. The results of this post-test showed that the ability of students to solve HOTS questions increased significantly where 75% of students were in the very good category and 25% were in the good category.

The improvement of each competency can also be seen by comparing the percentage of pre-test and post-test scores. Table 3 presents the value of students on each competency represented in each different question number. Based on the table, it can be seen that the science literacy of students has increased in all three competencies. For the competency of explaining scientific phenomena increased by 16.02, whereas with the R2L learning model, students can actually solve the HOTS questions given because they always relate scientific phenomena to those that occur in everyday life. The competency of evaluating and designing scientific investigations increased by 13.54. The competency of evaluating and designing scientific investigations is the competency that experienced the lowest increase compared to other competencies. These results indicate that learners have difficulty in answering questions related to how to evaluate and design scientific investigations. This is related to the finding that learners are not accustomed to identifying variables in experiments or tests conducted and teachers tend not to provide good stimulus to learners.

Table 3. Pre-test and post-test results on science literacy competency

Science literacy competencies	Number of Questions	Pre-test		Post-test	
		Mean	Standard Deviation	Mean	Standard Deviation
Explaining phenomena scientifically	8	69.14	3.31	85.16	2.31
Evaluate and design scientific investigations	6	66.15	2.48	79.69	2.07
Interpret data and evidence scientifically	6	64.58	3.14	81.25	2.90

The competency of interpreting data and evidence scientifically has increased by 16.67 and this competency is the competency that has the highest increase. This shows that learners have a high improvement in terms of converting data from one representation to another, analyzing and interpreting data and drawing appropriate conclusions, and evaluating arguments and scientific evidence from various sources. This is a positive effect that arises because learners have been trained using the R2L learning model. Learners are given the opportunity to read and understand the content of the reading well so that, with direction from the teacher, students can interpret the data provided and then use it to solve HOTS questions. In general, the results of the three competencies at the time of the pre-test were in the sufficient category, but after the application of the R2L learning model increased to a very good category; morevoer, these results have been validated and can be accounted for.

Reading skills are required in implementing the R2L learning model as it is based on science narrative text and being able to apply it. Learners are trained in the skills of understanding specific terms and phrases related to science, terms that have different meanings when used in science processes, interpreting scientific symbols and diagrams, recognizing common patterns in science texts, using deductive and inductive reasoning skills, and summarizing the reading (Petscher et al., 2020). The mental pressure for science teachers is that learners' motivation to learn through reading science texts is always decreasing. Science literacy is of great interest to science educators because the assessment of learners' conceptions of various important concepts in science is crucial for many lessons (Kotsis, 2024). Therefore, it is very important for teachers to always connect reading tasks with learners' real-world experiences. Learners will gain hands-on experience from reading science texts, and practicing appropriate reading strategies will improve their achievement.

Learners who engage in the learning process more actively, with greater interest, and with greater focus tend to have higher levels of science literacy. This is in line with the benefits of the R2L learning model, which also include enhancing learners' creativity and critical thinking, motivating them to learn, assisting them in applying their knowledge in new contexts, encouraging them to be creative and innovative in proving their problem-solving theories; and fostering the desire to collaborate and the ability to form strong bonds in group work Damayanti (2017) and Husein et al. (2022). Providing reading materials that use real-world issues that are

then used to collect data and draw conclusions, apply logic and its application in specific situations, and then apply these steps can solve problems and increase learners' knowledge. The application of the R2L model will provide opportunities for learners to learn better and more actively explore themselves because this model is student-centered (Harefa, 2023; Telaumbanua et al., 2023).

The implementation of science learning using HOTS questions with the R2L model provides learning progress for students with an increase in literacy skills according to PISA competencies of 0.42 with N-Gain achievement at a moderate level. This means that literacy-HOTS learning is very good in awakening the potential of students to be able to process thoughts, and understand and analyze text-based reading. There is a construction process by learners to find keywords and understand their meaning. Thus, meaningful learning occurs, and learners can convey key concepts of science knowledge through the learning experience even though they are not new to the science concept. This finding can be seen from the scores obtained from the results of students when doing the first test (pre-test), where students have not received learning treatment with the literacy-HOTS-based R2L learning model. After students get treatment, the final results or post-test have increased from an average value of 68.48 (sufficient category) to 83.75 (very good category).

4. CONCLUSION

The improvement of students' science literacy in understanding a reading to solve problems and address existing issues is needed. Based on the results of the study, there is evident progress in students' science literacy by using the R2L model and HOTS questions, as indicated by an increase in the pre-test to post-test score of 15.27 points and N-Gain of 0.42 with moderate criteria. Furthermore, after the application of the R2L model, it shows that there is an increase in the competence in explaining phenomena scientifically, evaluating and designing scientific investigations, and interpreting data and evidence scientifically. The application of the R2L model has given teachers the flexibility to adjust reading materials based on the ability of students and the situation of science learning so that the improvement of science literacy can be realized. For future research, HOTS questions can be formed in descriptive snaps so that the analysis of the improvement of science literacy skills can be seen thoroughly, and the samples used can be increased in the future.

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