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The Relationship Between Literacy Skills and Scientific Explanation on Students Scientific Reasoning Throught Reading Concept Map-Numbered Head Together Learning Model

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ABSTRACT

Literacy skills play an important role in helping students clarify basic concepts, build relationships between concepts, reason and test each detail of each interrelated information and are able to derive each concept, thus students are accustomed to understanding each scientific process and activity carried out in Biology learning. The relationship between these two skills trains students to actively carry out in-depth scientific investigations.The purpose of this study was to identify the relationship between scientific literacy skills and scientific explanation skills in empowering scientific reasoning skills through the application of the Remap-NHT (Reading Concept Map-Numbered Head Together) learning model. This study included a quasi-experiment using a non-equivalent pretest-post-test control group design with a total sample of 85 eleventh grade students in the Natural Sciences department at SMAN 4 Malang in the 2023/2024 academic year. The population was distributed into 3 groups. Scientific literacy skills and scientific reasoning skills were assessed using an essay test, while scientific explanation skills were assessed using an assessment rubric. Data analysis was tested using multiple regression analysis. The results showed that (1) there was a significant relationship between scientific literacy skills and scientific reasoning skills; (2) there is a significant relationship between scientific explanation skills and scientific reasoning skills; and (3) there is a significant relationship between scientific literacy skills and scientific explanation skills that have an integral effect on scientific reasoning skills. The interrelationship between scientific literacy skills, scientific explanation skills and scientific reasoning skills can be observed in the regression equation Y = 0.317 * X1 + 0.995 * X2 + 30.113. Based on the findings, it is concluded that Remap-NHT is able to improve students' scientific literacy skills, scientific explanation skills, and scientific reasoning skills, the interrelationships of which influence each other.

KEYWORDS

Remap NHT,
Literation,
Scientific Explanation,
Scintific reasoning

1. Introduction

In general, the educational paradigm is oriented towards students' abilities that are adjusted to the demands of the 21st century. The increasingly rapid advancement of technology has become a demand for every individual to develop their potential in each related skill domain (Irawan, 2022). Some of the abilities in question are scientific literacy skills and scientific explanation skills in order to be able to derive every scientific concept that must be understood simultaneously. This must be an activity that is practiced continuously (Zhou, 2021)

Each skill leads to the ability of students to associate each concept that has diversity, so that students' ability to understand concepts and analyze these concepts in a structured manner is needed, which is adjusted to the demands of 21st Century learning to construct knowledge through scientific

literacy skills activities to examine concepts continuously and can be measured properly (Bishop, 2021) and students' ability to carry out investigative activities through a scientific process approach or through practical activities so that students are able to provide claims/explanations supported by scientific evidence obtained from practical activities to understand applicable concepts, principles or theories (Irawan et al., 2021)

Students who have scientific literacy skills are able to integrate each basic concept sequentially and in detail by showing scientific facts that are in accordance with the concept with learning theory, with scientific phenomena that they often encounter in everyday life. (Kalkan et al., 2020) thus every basic concept they express has systematic continuity, to support scientific knowledge, scientific process skills, and scientific attitudes which are the main components of scientific literacy skills can be achieved optimally (Ma & Qin, 2021) and guide students to study at school continuously, to develop the knowledge they have in meeting the needs of life which are greatly influenced by the development of science and technology (Li et al., 2020).

Science literacy skills help students become sensitive to scientific concepts and are able to optimize learning experiences and are able to direct students to build knowledge through meaningful learning activities (deep learning) (Al Sultan, Henson, and Lickteig 2021) based on investigative activities on scientific phenomena and foster students' curiosity to solve complex problems that are often encountered in everyday life (Hernández-Torrano & Ibrayeva, 2020)

Another skill that needs to be empowered to students is the Scientific Explanation skill which directs students to understand phenomena based on scientific knowledge (Putra & Rahman, 2019) so that students are actively involved in exploring information from various scientific sources that support the occurrence of a phenomenon (Zou'bi, 2021) because scientific explanation is a very important ability because it contains an explanation that provides reasons for the occurrence of a phenomenon scientifically and the underlying theory (Demirtaş & Batdal Karaduman, 2021). In the biology learning process, the main indicator that must be considered is the ability of students to be able to provide interconnections as the main indicator of achieving Scientific Explanation skills.

The results of previous research conducted in 2021 (Lei et al. 2021) explained that scientific literacy skills facilitate students to actively understand each concept dynamically which is supported by valid and significant scientific evidence to improve students' Scientific Explanation skills in associating each scientific fact (Camacho, 2021) and train students' scientific reasoning skills in determining the correlation of each concept supported by strong facts (Polat & Aydın, 2020)

Scientific literacy skills and Scientific Explanation skills are related to scientific reasoning skills. Scientific reasoning skills direct students to be able to trace various ideas by thinking metaphorically (Woody, 2015). The results of the study showed that these three skills are interrelated in training students to explore original ideas, according to the scientific evidence they compile as a form of learning experience through a science process approach (Haber et al,. 2021)

The main obstacle faced by students in learning activities is that the right method has not been found to link scientific facts as a comparison to general and comprehensive scientific concepts (Liebech-Lien, 2021). This happens because students have not been able to associate every piece of information they obtain, and empirical data shows that students' ability to organize the initial ideas they obtain and map the concept in a structured manner only reaches 28.85% (Peña-Ayala, 2021).

Another cause is that the instructional objectives in the learning process have not optimally improved students' skills in conveying each idea/concept, making decisions, collecting scientific evidence to solve problems have not been developed (Zhang & Chen 2021) so that the competencies needed by students as a form of a combination of skills, knowledge and scientific attitudes that are reflected in habits of thinking and acting have not been achieved (Tan et al., 2021). In other hand, There has been no research that implicitly discusses the relationship between scientific literacy skills and argumentation skills that can be trained in students through the use of innovative learning models that are oriented towards in-depth learning processes.

Through the Remap NHT learning model, students are trained to provide original thinking results on the concepts/materials being studied, so that this is in line with the research objective to improve students' creative thinking skills through the integration of scientific literacy skills to solve scientific problems using a scientific process approach and provide arguments for the scientific processes they observe so that it is significantly able to improve students' scientific argumentation skills by providing scientific evidence in accordance with generally applicable concepts.

The implementation of learning activities in schools that are not optimal has an impact on the learning process which is less interesting so that students are less active in accessing information related to learning materials (Ren et al., 2021) so that students do not feel a pleasant learning environment. For this reason, an innovative learning model is needed as the main facilitator to develop scientific literacy skills, Scientific Explanation, and interrelated scientific reasoning skills (Ekman, 2021).

One of the innovative learning models that can be used as a solution to these obstacles is the Remap NHT learning model which integrates Reading activities, Concept Maps, with the NHT type cooperative learning model (Zubaidah et al. 2018). Reading activities provide experience for students in finding ideas or main ideas for each learning sub-material, and are able to derive the material consistently and describe it hierarchically through the process of compiling concept maps, as well as the NHT cooperative learning model which plays a role in training students to learn comprehensively in compiling and informing each concept they have received (Irawan et al., 2020).

Based on the description above, the purpose of this study is to determine the relationship between scientific literacy skills, Scientific Explanation, and scientific reasoning skills through the use of the Remap NHT learning model which can be used as an alternative to empower these skills to students in a sustainable manner

This research is very important to do because through this research we can train several basic skills that must be possessed by students in biology learning through the use of innovative learning models and provide space for students to develop their scientific reasoning abilities simultaneously

2. Method

This research is a correlation experiment research with a sampling technique using Cluster Sampling. The population in the study included all students of class XI IPA at SMAN 4 Malang in the 2024 academic year totaling 7 classes. The sample was obtained through the results of the equivalence test, which was divided into 3 classes. The material used was the material on the motor system and blood circulation system which was applied through the use of the Remap NHT learning model. Data collection and collection used essay questions totaling 6 questions arranged based on indicators of scientific literacy skills and scientific reasoning skills, while the assessment of Scientific Explanation skills used an assessment questionnaire. Validity and reliability tests were carried out on the research instrument by expert validators. The instrument was validated by 3 expert lecturers who conducted validity tests in the form of content validity and construct validity until the 10 questions used met the standard validity criteria and were suitable for use in the research process.

The results obtained showed that each question met the validity requirements and were proven by the Pearson correlation test, each question item showed a significance value <0.05, and the reliability of the questions reached a Cronbach's alpha value of 0.895 which met the criteria for being very reliable. The data were analyzed using the SPSS application consisting of 2 stages, namely, 1) prerequisite test through the Kolmogorov Smirnov test to determine the normality of the data obtained during the research activities, and the homogeneity test which aims to determine the distribution of homogeneity of data for each variable measured, 2) and linearity test to identify the linearity/significance of each variable component. The multicollinearity test is used to determine whether a correlation exists between independent or dependent variables in the regression model. The results of this multicollinearity test yield high values for the variables in the sample, meaning the standard error is large. The variance inflation factor (VIF) and tolerance are used to determine the presence or absence

of multicollinearity in the regression model, Based on the results of the prerequisite test, the data collected is normal, homogeneous and shows linear properties, so further analysis is carried out using Multiple Regression analysis with a significance value of 5% (0.05).

3. Results and Discussion

The results of the multiple regression test analysis that explain the relationship between the Integral Skills of Scientific Literacy and Scientific Explanation Skills with students' scientific reasoning skills are shown in Table 1. Scientific literacy skills and Scientific explanation skills provide effective contribution support of up to 53% to scientific reasoning skills which can be observed in the R square value in Table 1.

Table 1. Results of Multiple Regression Test of Interconnective Relationships between Scientific Literacy Skills and Scientific Explanation Skills

Nimbered	*R*	*R square*	*Adjusted R Square*	*Std. Error of the Estimate*
1	0.885[a]	0.553	0.478	8.84674

Table 1 describes the correlation value of 0.885 and the R-square value of 0.553 These values indicate that 55.33% of scientific reasoning skills are influenced by scientific literacy skills, while other factors have an influence of 47.80%. The results of the regression analysis test to determine the integrative relationship between scientific literacy skills and Scientific Explanation skills with scientific reasoning skills are in Table 2 Based on Table 2, it is obtained that the significance value of scientific literacy skills reaches 0.000, thus the significance value of 0.000 <0.05. This shows the relationship between scientific literacy skills and students' scientific reasoning skills. The interrelationship of Scientific Explanation skills with students' scientific reasoning skills obtains a significance value of 0.000, which indicates a significance value of 0.001 <0.05, this is the basis for determining the relationship between Scientific Explanation and scientific reasoning skills. This shows that scientific literacy skills and scientific explanation skills partially have an important role in the process of empowering students' scientific reasoning skills in a sustainable manner. Table 2 presents the results of the partial multiple regression analysis conducted to examine the influence of scientific literacy skills and scientific explanation skills. The Table 2 shows the unstandardized and standardized coefficients, standard errors, t-values, and significance levels for each predictor.

Table 2. Results of Partial Multiple Regression Test Between Scientific Literacy Skills and Scientific Explanation Skills

Model		*Unstandardized Coefficients*		*Standardized Coefficients*	*t*	*Sig.*
		B	*Std. Error*	*Beta*		
1	(Constant)	29,110	,25		14,317	,000
	Literation Skills	,899	,0033	,408	182,743	,000
2	Scientific Explanation	,317	,075	,545	1,995	,000

The determination of the regression equation is obtained by multiplying the value of B by the independent variable used. The following regression equation is obtained:

Y= 0.317*X1+0.995*X2+30.113

Description:

Y = Scientific reasoning Skills

X1 = Science Literacy Skills

X2 = Scientific Explanation Skills

The results of the study show that there is a significant relationship between science literacy skills and Scientific Explanation skills with scientific reasoning skills, which are empowered to students through the use of the Remap NHT learning model. The substance of the Remap NHT learning

model provides very effective support for training these skills by facilitating a fun learning process in every activity or syntax (Hamadi et al., 2021), so that students are able to access every idea needed to develop concepts that have novelty value and can be accepted by other students (Oliveira et al., 2021).

Reading activities as initial activities in the Remap NHT learning syntax facilitate students to collect information that is in accordance with the learning material and then organize it into primary ideas extracted from reading sources used by students to compile the initial information (Sewasew & Koester, 2019). The factual concepts obtained by students are reorganized into accurate and complete scientific data, according to appropriate scientific principles (Dolničar et al., 2020) to explain each data obtained and adjusted to the initial information that students have collected so that students' scientific reasoning skills are directly trained through a divergent thinking process to produce ideas as scientific reasoning products (Zhou, 2021)

Information compiled from primary data that has been collected by students as a result of their own thinking, makes students individuals who are skilled at conveying every idea fluently (Tikva & Tambouris, 2021). This is supported by other studies (Danovitch et al., 2021) which state that the main treatment that must be done in training Scientific Explanation skills is by creating a learning environment that accustoms students to have scientific behavior including curiosity, objectivity, creativity, innovation, and caring for the environment in daily activities as a form of implementing attitudes in conducting experiments/discussions in class (Luo et al., 2021).

The next syntax, students create a concept map (Figure 1). Students' initial ideas become a reference for creating a concept map. The main role of a concept map is to help students identify the alignment of each concept that is formed and combined in a hierarchical form. (Bilik et al., 2020). The concept map described by students becomes scientific evidence for students to express relatively fluent complex ideas on the topic of Biology learning and engage in the practice of scientific approaches/exploration of new phenomena in accordance with the objectives of the learning material. Thus, the concepts expressed by students through concept maps are concrete.

Concept maps are compiled based on the scientific information they obtain as primary data, so that the explanation of each important term is complete and shows the relationship of each related information (James et al., 2022). Making concept maps is a constructive process that involves knowledge that involves clarifying scientific meaning effectively empowering Scientific Explanation skills (Reiska et al. ,2015).Identification of the alignment of each concept connected by students makes concept maps a scientific product designed by students systematically (Li et al., 2021), which reflects the structure of students' level of understanding and displays the reciprocal relationships between their ideas that directly train scientific literacy skills and scientific reasoning skills (Rainey et al., 2020).

Figure 1 illustrates a concept map of the circulatory system, which outlines the key components and their interrelationships. The map highlights the main aspects of blood circulation, including the heart, blood vessels, and types of circulation, as well as factors that influence the circulatory process such as lifestyle and infection. Figure 1 shows that students are able to perform a comprehensive visualization related to the specific relationship between concepts and the hierarchical structure of each learning material (topic). This process accommodates students to form a hierarchical arrangement, and new information obtained is processed to produce a specific concept. In the concept map, it appears that students are able to associate concepts naturally with the association process to connect each piece of information that has been obtained until the concept maps formed by students are structured and do not overlap.

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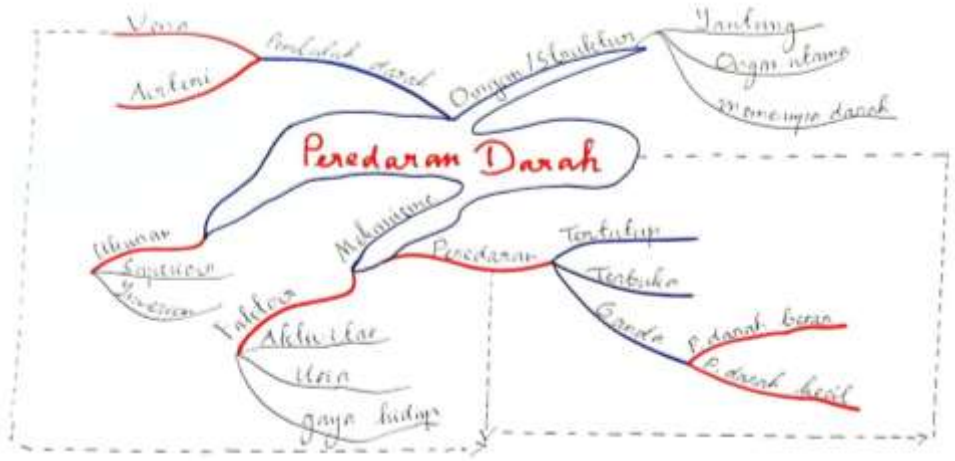

Figure1. Concept Map of the Circulatory System

Translation for picture 1

Sistem peredaran Darah: Circulatory Sistem	Komponen: Component
Darah: Blood	Jenis:Type
Jantung: Cardiac	Pembuluh Arteri:Arteri Vessel
Pembuluh darah: Blood vessels	Pembuluh vena: Vena vessel
Sel darah : Blood Cell	Pembuluh kapiler:Capiler Vessel
Plasma darah : Blood plasm	Limfatik: Limfatic
Dinding jantung :Cardiac wall	Selaput jantung:Cardiac plasm
Ruang jantung :Cardiac Room	

Empowerment of scientific literacy skills has a close relationship with students' scientific reasoning skills. The process of empowering students' scientific literacy skills through students' scientific attitudes to carry out structured practical activities (Dichev & Dicheva, 2017) in understanding, applying, and analyzing factual, conceptual, procedural knowledge, and based on students' curiosity (Atesgoz & Sak, 2021) related to the causes of phenomena and events, as well as applying procedural knowledge specifically to solve problems (Ivanova et al. 2021).

In the practical activities carried out to practice scientific literacy skills, students carry out practical work with different practical sub-topics. This is in accordance with the results of previous studies which revealed (Jach & Buczek ,2021) that practical activities involve all active students during learning activities, students divide their respective tasks when conducting experiments, (Yildiz & Yildiz, 2021) to conclude the results of the practical activities they have done, so that this is simultaneous to practice scientific literacy skills and scientific explanation skills simultaneously/continuously (Berndt et al., 2021)

One of the statements of the students with the initials RD stated that "I am always active in conducting experiments and asking questions because I am interested in this learning. The learning that is applied is a new learning that I have obtained and I think it is very interesting". Thus, the learning activities carried out are able to make students enthusiastic in every design of practical activities carried out so that they directly conduct scientific investigations that are able to access the thinking skills of scientific literacy and scientific explanation through discussions to make a decision related to the analysis of observation data (practicum).

The relevance of other follow-up research results states that improving students' scientific literacy and scientific explanation skills is influenced by students' capacity to solve problems (Leal Filho et al. 2021) and their ability to provide formative assessments through feedback on the problem-solving process by associating each data and fact that they obtain from various valid and credible sources (Danovitch et al., 2021)

The novelty of ideas presented directly can empower students' scientific reasoning skills (Matsumoto-Royo & Ramírez-Montoya, 2021). Through investigation or exploration and collecting relevant scientific evidence, an intuitive attitude to combine ideas and scientific evidence that has been obtained is the main indicator of achieving scientific reasoning skills (Alt & Raichel, 2020)

Scientific explanation skills and scientific literacy skills have a reciprocal relationship with students' scientific reasoning skills (Wankhede, 2020). Activities that influence the increase in students' scientific explanation skills are the process of determining problem formulations, hypotheses, and data analysis to formulate problem formulations and hypotheses in making claims (Pagliaro, 2020) to find out the relationship between data obtained by students through literacy activities through various reading sources as a tool to access each actual information in different forms that require students' scientific reasoning skills in linking the information (Palma & Reis, 2021)

Remap NHT learning provides a positive contribution to assessing the science process seen in NHT syntax when students share tasks in solving problems, collecting scientific evidence, and the process of conveying information which is the idea of each group member (Adawiyah et al., 2021). Students combine ideas to be able to observe and classify each information that has been obtained as a result of investigation (Zahra et al. 2021) and exploration in the context of science activities through scientific explanation as evidence of investigation into scientific understanding which is the main product of scientific literacy skills (Lobczowski et al., 2020)

Through the integration of the Remap NHT learning model which trains students to provide analogical reasoning which is arranged in the form of a concept map, it can be a representation of the ability to abstract each concept coherently accompanied by valid scientific evidence

4. Conclusion

Science literacy skills and Scientific Explanation skills have a relationship to students' scientific reasoning skills, as evidenced by the percentage of effective contributions reched 53% which include in high category. The syntax in the Remap NHT model creates learning activities that support the achievement of science literacy skills, communication and active scientific reasoning. Thus, scientific literacy skills and scientific explanation skills have a dynamic relationship in empowering each sub-indicator of scientific reasoning skills. For further relevant, especially those that specifically discuss the integration of 21st century skills which must be developed dynamically. It is recommended to compile a rubric for assessing literacy skills and scientific writing abilities holistically and analytically to facilitate the implementation process.

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