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Analysis of Changes in Students' Scientific Literacy Ability After Attending Lectures Using the RADEC Model

Wati Sukmawati[1*], Zulherman[1]

[1] Primary Teacher Education, FKIP, University of Muhammadiyah Prof. DR. HAMKA, Indonesia.

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Corresponding Author:
Wati Sukmawati
wati_sukmawati@uhamka.ac.id

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Abstract: This study aims to analyze Changes in Students' Scientific Literacy Ability in lectures on the basic concepts of science, the subject matter and the characters trained during lectures using the RADEC model (Read, Answer, Discuss, Explain, and Create) using the Rasch model stacking analysis. This descriptive research is a quantitative study with a sample of 42 first year students. The data were obtained from scientific literacy tests, then the data were analyzed using the Rasch model stacking analysis. The results showed that students with low and high abilities experienced changes in scientific literacy skills for the better. During learning with the RADEC model students are trained to study independently and in groups at the read and answer stages, students are also trained to express opinions and learn to accept opinions from other friends during the discuss and explain stages. At the create stage, students are facilitated in applying material concepts to solve problems in everyday life so that students are trained in scientific literacy.

Keywords: RADEC; Scientific Literacy; Stacking

Introduction

Scientific literacy is a benchmark for the implementation of science education which is taught to all students, from elementary to tertiary education. In science education students are trained to become individuals who are scientifically literate or scientifically literate. Based on the results of the PISA (Program for International Student Assessment) survey conducted by The Organization for Economic Co-Operation and Development (OECD) in 2018, it was revealed that Indonesian students have a low level of scientific literacy among other countries. Indonesian science students according to TIMSS (Trends in International Mathematics and Science Study) in 2018 are ranked fourth lowest out of 47 countries participating in the survey (OECD, 2018). These findings are a factor causing students' low scientific literacy skills. This condition can be seen in previous research including research on nursing students which shows a lack of literacy results in a lack of academic performance (Glew et al., 2019), the lack of scientific literacy abilities of prospective science teacher students (Jamaluddin et al., 2019). Several study results show that students' scientific literacy skills are still at a low level.

This condition certainly reflects the need for continuous improvement and quality improvement in the process of learning science, which is better known as Natural Sciences (IPA) in Indonesia. What's more, in 21st century education scientific literacy is one of the key competencies that students need to master and can be a solution in responding to the challenges of global competition (Ding, 2022). Like previous research on prospective elementary school teacher students by applying local wisdom-based practicums can improve student literacy skills (Sukmawati et al., 2022). Through scientific literacy, a person has the ability to understand and apply the knowledge learned, organize, analyze and interpret various sources of scientific information in order to decide on solving problems that occur in his life (Dragoş & Mih, 2015).

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Apart from that, scientific literacy also has an impact on a person's character to make him have a more caring or sensitive attitude towards the environment (Carl et al., 2016; Lee et al., 2015).

The low scientific literacy of students is partly due to the use of inappropriate approaches, methods, strategies and learning models Sukmawati et al. (2021), learning that tends to be teacher centered, and not oriented towards the process of character formation (Boulton, 2017; Hagermoser Sanetti & Collier-Meek, 2019). Learning that directs students to be active is of course a student-centered learning by applying the principles of constructivism learning theory (Sukmawati et al., 2022). When science learning is carried out, students are active in carrying out the inquiry process to build their own knowledge. Referring to the results of a literature review from several previous studies which state that scientific literacy requires learning based on student active learning, the researcher tries to recommend an innovative learning model that can be used to overcome this problem, namely through the application of the Read, Answer, Discuss, Explain, learning model. and Create, or what is known by the abbreviation RADEC.

RADEC learning is a learning model that has an implementation syntax consisting of: Read, Answer, Discuss, Explain, and Create. This sequence of activity steps or syntax is the basis for mentioning the RADEC learning model (Sopandi, 2019). Besides being developed based on constructivism learning theory, learning syntax that is easy to remember and applied by lecturers is an advantage. This learning model is also an innovation model developed by focusing on student proficiency in HOTS (High Order Thinking Skill) learning, multiliteracy learning, and character learning as 21st century skills. Judging from these profiles and characteristics, then RADEC as a learning model can be an option. problem solving in helping teachers to develop scientific literacy in their classes. The profile and characteristics of RADEC as a learning model can be used as a rationalization for solving the problem of low scientific literacy caused by learning that tends to be teacher centered and learning that is not oriented towards building a caring character for the environment. In addition, the use of this model for the effectiveness of developing scientific literacy in tertiary institutions is a novelty that is different from previous studies. This study focuses on the problem of how the results of the analysis of changes in students' scientific literacy abilities after participating in learning using the RADEC model?

Method

This research was conducted using a descriptive research design with a quantitative approach. The data analysis technique uses the Rasch model stacking analysis to analyze changes in students' scientific literacy skills before and after attending lectures using the RADEC model. The subjects in this study were students of the TA basic science concept class 2021/2022. The sampling technique used random sampling according to the Rasch model (Sumintono, 2018)as many as 100 students.

The research instrument used in this study was scientific literacy-based items on the subject matter. The instrument consists of 20 multiple choice questions. The discourse text contained in the items includes the process of forming salt, the process of grouping material in tea drinks, the process of changing material in making ice cream, and the process of separating material in water purification. Each text contains 5 multiple choice questions. Based on the developed text, students are expected to be able to determine material and its properties, classify material, analyze material changes, and be able to determine how to separate material. Each question from the existing discourse has 5 points with a total of 20 questions, so the maximum score is 100.

Research data analysis techniques include descriptive analysis and quantitative data analysis using the Winstep 3.73 application (Sumintono & Widhiarso, 2015). Quantitative data were obtained from student test results (pre and postests), namely before and after learning. The test results were analyzed using the Rasch dichotomy model, a stacking method to find out how significant changes in scientific literacy skills are measured from pre-test and post-test scores (Laliyo, 2021). Stacking analysis is a technique for analyzing changes at the individual level (Wright, 2003). In carrying out the analysis with the stacking technique, it can be carried out through eight stages (Laliyo, 2021).

These stages are based on the Rasch model rating analysis approach. Here are the steps: 1). Scoring is done on student answers and adjusted to the level of scientific literacy ability of students so that the data obtained is polytomous data; 2). Tabulating polytomous data into excel and the resulting data *pretest* and posttest separated; 3). Converting data using the WINSTEP application version 3.73 into interval data that has the same measurement scale; 4). Measuring the effectiveness of the instrument seen from the value of the validity and reliability of persons and items; 5). Define item validation using tests*item statistics misfit orders;* 6). Using the test results*person measure pretest*and posttest to test the hypothesis; 7). Comparing the scientific literacy skills acquired by each student; 8). Comparing scientific literacy skills before and after treatment.

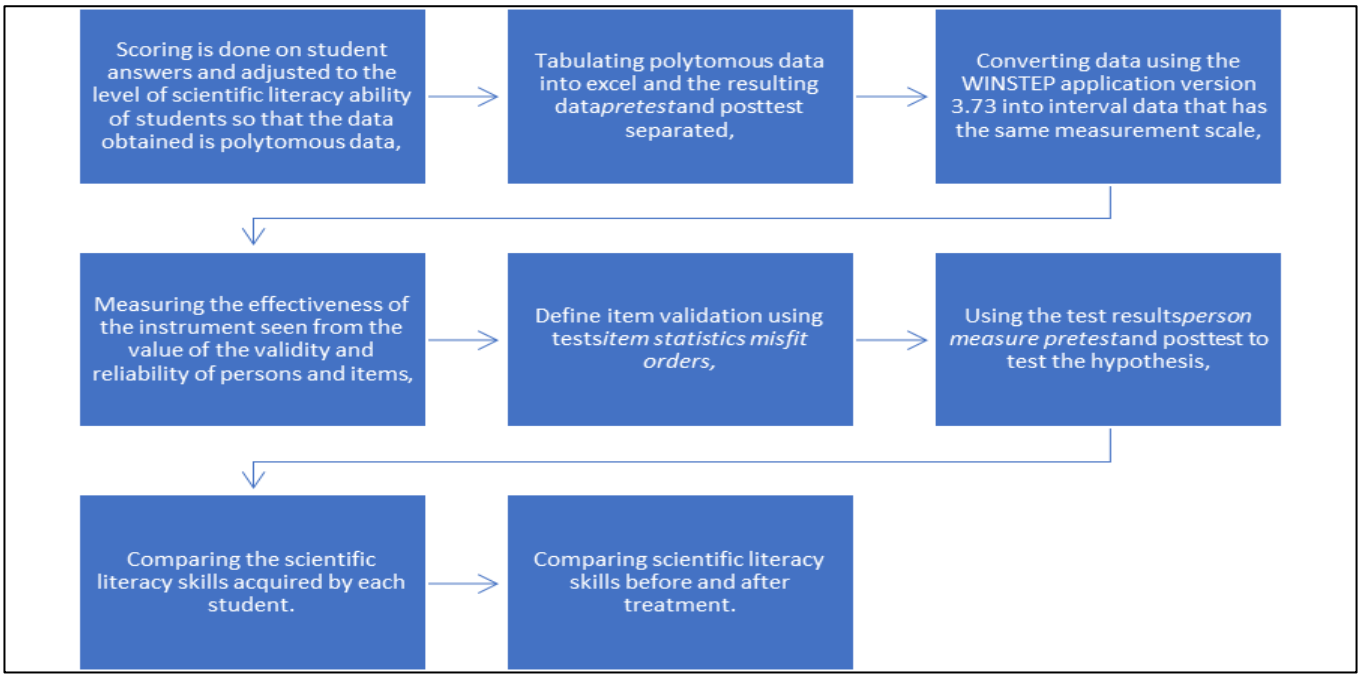

Figure 1. These stages are based on the Rasch model rating analysis approach

Result and Discussion

In this study, the use of the RADEC model in an effort to improve students' scientific literacy abilities was used as a treatment that researchers carried out to achieve this goal. The learning process that students follow is in accordance with the RADEC stages, namely Read, Answer, Discuss, Explain, and Create.

Figure 2. Stages of the RADEC Learning Model

Changes in students' scientific literacy skills can be seen from the results of the pretest and posttest that students obtain. Judging from the results of the pretest and posttest scores of students who were processed using the Rasch model, the reliability value of the person category was very good, namely with a value of 0.94 with a separation value of 3.99. The data showed that students were consistent in answering questions and the quality of questions was sensitive to measure all student categories (Sukmawati et al., 2022). As for the reliability value of the item, it is included in the good category with a value of 0.90 and a separation value of 3.04. The data shows that the respondents varied in responding to the questions given. For more details, it can be seen in Table 1.

Table 1. Person and Item Reliability Value

Person		84 Inputs		84 Measured		Infit		Outfit
	Total	Count	Measure	Realse	Imnsq	Zstd	Omnsq	Zstd
Mean	64.0	20.0	3.74	.66	.99	-.2	1.08	-.1
S.D.	10.9	.0	3.06	.33	.53	1.6	.70	1.6
Real Rmse	.74	True Sd	2.97		Separation 3.99		Person Reliability	.094
Item		20 Input		20 Measured		Infit		Outfit
	Total	Count	Measure	Realse	Imnsq	Zstd	Omnsq	Zstd
Mean	269.0	84.0	.00	.27	.99	-.1	1.08	.2
S.D.	12.9	.0	.87	.02	.19	1.2	.46	1.5
Real Rmse	.27	True Sd			Separation 3.04		Person Reliability	.90

With good item and person reliability values, it can be ensured that the instruments used can measure scientific literacy skills well (Sumintono, 2018). Based on these data, the instrument questions were used for the

pretest and posttest. After the results of the student pretest and posttest were obtained, they were processed and a stacking analysis was carried out using the Rasch model. Following are the results of changes in students' scientific literacy abilities after attending lectures with the RADEC model when viewed from changes in the logit/measure values as shown in table 2.

Table 2. Changes in Student Measure Scores from Pretest and Posttest Results

Person	Measures		Enhancement	Category
	Pretest	Posttest		
1	0.9	4.85	3.95	Good
2	2.82	9.57	6.75	Very good
3	-0.21	5.07	5.28	Very good
4	6.05	9.57	3.52	Good
5	2.23	8.31	6.08	Very good
6	0	2.52	2.52	Enough
7	-2.52	2.52	5.04	Good
8	1.14	6.33	5.19	Very good
9	1.39	4.39	3	Good
10	1.94	7.03	5.09	Good
11	-1.38	5.54	6.92	Very good
12	4.39	8.31	3.92	Good
13	3.11	5.3	2.19	Enough
14	0	5.54	5.54	Very good
15	0.22	1.66	1.44	Enough
16	-3.11	3.66	6.77	Very good
17	-0.66	4.39	5.05	Good
18	2.52	5.78	3.26	Good
19	0.22	5.07	4.85	Good
20	0	5.07	5.07	Good
21	-1.13	4.16	5.29	Very good
22	-0.43	2.52	2.95	Good
23	0	6.33	6.33	Very good
24	2.52	9.57	7.05	Very good
25	0.44	5.78	5.34	Very good
26	5.78	9.57	3.79	Good
27	2.82	8.31	5.49	Very good
28	-0.89	4.39	5.28	Very good
29	2.52	3.91	1.39	Enough
30	0.67	5.07	4.4	Good
31	3.66	6.05	2.39	Enough
32	1.14	6.05	4.91	Good
33	1.94	5.07	3.13	Good
34	5.54	8.31	2.77	Good
35	2.52	5.54	3.02	Good
36	3.39	7.53	4.14	Good
37	2.23	5.54	3.31	Good
38	-0.66	5.07	5.73	Very good
39	1.94	8.31	6.37	Very good
40	2.52	7.03	4.51	Good
41	6.33	9.57	3.24	Good
42	2.82	5.54	2.72	Good
			Mean: 5.17 SD: 2.58	
			Very Good:35.7%; Good:52.4%; Enough:11.9%	

Based on the data in table 2, it can be seen that all students experienced an increase in scientific literacy skills after attending lectures using the RADEC model. Changes in scientific literacy skills experienced by students occur evenly in both low, medium and high group students. Changes in scientific literacy skills seem to increase very well in student numbers (2, 3, 5, 8, 11, 14, 16, 21, 23, 24, 25, 27, 28, 38, 39), students who experience increased literacy skills Science with good categories occurs in student numbers (1, 4, 7, 9, 10, 12, 17, 18, 19, 20, 22, 26, 30, 32, 33, 34, 35, 36, 37, 40, 41 , 42), and students who experienced an increase in scientific literacy skills with an adequate category occurred in student numbers (6, 13, 15, 29, 31). For more details, it can be seen in Figure 1.

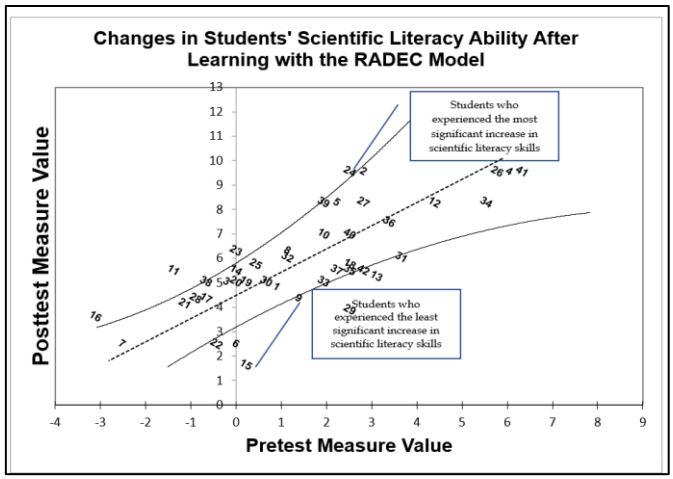

Figure 3. Stacking Graph of Changes in Scientific Literacy Ability Due to Learning the RADEC Model

The increase in students' scientific literacy skills is due to the use of the RADEC model which trains students to use their conceptual knowledge to solve existing problems in the field and in the learning process trains students to be independent and collaborate so that lectures are student-centered. The RADEC learning model has a positive influence on students' scientific literacy abilities (Pratama et al., 2020).

The RADEC learning model provides improvements to all students even though the improvements experienced vary from very good, good, and sufficient categories. The thing that underlies the improvement of students' scientific literacy skills after attending lectures with the RADEC model is the use of the RADEC learning model syntax according to the characteristics of students and learning in Indonesia. The first syntax is read which directs students to study independently so that students are trained to read and build understanding of concepts independently. The more reading sources read by students, the higher student literacy skills (Lestari et al., 2022). Furthermore, to direct students in reading, the lecturer gives pre-

learning questions. This stage is known as the answer stage.

Students are given contextual-based essay questions by lecturers to train students' scientific literacy skills and then students answer independently, questions given to students are questions that are in accordance with learning objectives and indicators including determining material and its nature, classifying material, analyzing changes in material, and being able to determine how to to separate the material. With read and answer activities carried out by students before participating in the lecture process, the learning process can then be focused on things that students do not understand, and this is what is called effective learning (Sopandi. W, 2017).

Each student has the provisions to study in class and is ready for the next stage, namely the discuss and explain stages. At the discuss stage, students actively discuss in small groups. This activity makes students exchange ideas and express opinions so that they get the best answer that will be presented. In addition to practicing communication, during the discuss stage students train critical-analytical skills during discussion activities (Sopandi & Handayani, 2019). After participating in the discussion stage in small groups, students follow the explain stage which trains students in developing their higher-order thinking skills and scientific literacy skills in responding to the results of other group discussions.

Figure 4. Discuss and Explain Stage

Then the last stage is the create stage, students are trained to apply knowledge of material concepts to solve problems or create works (Sujana et al., 2021; Zulfa et al., 2021). In this activity students are trained to develop creative ideas, design a work or provide a solution to a problem encountered so that they are trained to be scientifically literate. If in other learning models students are focused on mastering the material or compiling solutions to problems that have been prepared, for the RADEC model students actively and creatively compile or create solutions to problems that arise independently with the conceptual knowledge that students have.

Conclusion

Based on the findings and discussion that have been put forward, it can be concluded that students' scientific literacy abilities after attending lectures using the RADEC learning model have increased to a very good category of 35.7%; good at 52.4%; and sufficient by 11.9%. This increase can be measured or pretest and posttest logit values. The measure value or logit value shows the student's ability to answer questions based on the level of difficulty of the problem. Measure or logit values are obtained from raw scores obtained by students and then processed using Rasch. This increase occurred in groups of students who had low or high initial abilities. Even, it was also found that many students with very low initial abilities after participating in the learning process entered into a group of students who experienced an increase in the very good category. Treatment carried out during learning using the RADEC model directs students to build their scientific literacy skills starting from independent study and learning from their immediate environment at the read stage, answer, discuss, explain, and create stage.

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