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# Sharpening Students' Science Literacy Skills with The Numbered Heads Together Cooperative Model Based on Socio-Scientific Issue

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**Abstract.** The importance of science literacy skills in the 21st century today can help a person have the knowledge to solve problems in everyday life. Science literacy in society has the potential to help answer unsolved problems related to socio-scientific issue (SSI). Through a teamwork-orientated learning model, this can stimulate students' science literacy skills. The purpose of this study was to stimulate students with the numbered heads together cooperative model with the SSI approach to improve their science literacy skills. The research was conducted by involving 36 students from science education department. The research used quantitative method. The results showed that there were differences before and after learning by using the numbered heads together cooperative model. The results tested by N-Gain analysis showed that the use of cooperative learning model numbered heads together based on SSI can improve students' science literacy skills with an N-Gain score of 0.45 in the medium category.
**Keywords:** Science literacy, NHT, SSI

## Introduction

Entering the 21st century today, science literacy skills are one of the basic literacy skills that must be mastered. The importance of science literacy skills can help a person have the knowledge to solve problems in everyday life (Rahardhian, 2023). Science literacy is known to have a concrete contribution in shaping life skills in a person (Azizah & Budiyanto, 2020). Science literacy affects a person's ability to use the sciences, identify scientific questions, and draw conclusions based on concrete evidence, to make appropriate decisions regarding nature and human activities (Wijayanti, 2016). Science literacy is a useful ability for a person to produce scientific products through processing scientific information in solving scientific problems (Astuti et al., 2021).

Based on international data, Indonesia is one of the countries with low science literacy skills. This is evidenced by the latest PISA research in 2022 quoted from OECD showing the science literacy scores of Indonesian students from PISA 2018 to PISA 2022 decreased by 13 points. Indonesia is ranked 68th and the average science literacy score is 398, below the average of OECD countries which is 495 (OECD, 2023a). Low science literacy can have an impact on a person's lack of ability to develop and improve creative abilities to use the knowledge they have in everyday life, have difficulty in problem solving, and are slow in making decisions (Yusmar & Fadilah, 2023).

Science literacy skills are related to the phenomenon of socio-scientific issues. It can be seen that science literacy in society has the potential to help answer unsolved problems related to SSI to enable society to become a smart and responsible society (Li & Guo, 2021). Integrating socio-scientific issues in science learning is one of the significant transformations in science education (Widiyawati, 2020). The SSI pproach is a more advanced pedagogical strategy to empower learners or students to consider the ethical and moral dimensions of science-related issues (Kumar et al., 2024).

SSI can be classified as a global issue related to culture and society (Wiyarsi et al., 2023). The involvement of SSI in science learning can provide a significant transformation in science learning. The involvement of SSI in science learning can provide opportunities for students to get more opportunities to think and utilise their knowledge to solve existing problems (Widiyawati, 2020). SSI-orientated learning can encourage students' capacity to have good reasoning (Kristensen & Knain, 2024).

Optimisation of learning approaches in learning activities is supported by the use of appropriate learning models. The use of learning models is a reference to the effectiveness of managing the learning process, in this case, improving science literacy skills. The numbered heads together learning model is one of the cooperative learning models that involves many students or learners. This learning model emphasises a structure that is specifically designed to be able to influence the pattern of interaction between students which can affect students' interest in learning. The use of the numbered heads together model is known to affect science literacy skills (Bayu et al., 2023).

The integration of the numbered head together model with the SSI approach is known to develop cooperation between students in each group, each student is required to actively participate in the learning process. Uniquely, the discussion that is built focuses on scientific issues in everyday life that can be found in everyday life which can develop critical thinking skills and increase a sense of social concern for the surrounding environment (Huriljannah & Ekapti, 2024). This can be one of the efforts to deal with environmental pollution. As it is known that environmental pollution greatly affects the lives of living things (Awewomom et al., 2024).

In relation to the integration of the cooperative model of numbered heads together with the SSI approach, it is expected to affect the science literacy skills of undergraduate students majoring in science education at one of the universities in Surabaya. Previous research has shown that the numbered heads together cooperative model and the SSI approach can affect an individual's science literacy skills (Bayu et al., 2023 and Li & Guo, 2021). The SSI approach is known to be able to empower students in determining scientific decisions that have to do with their surrounding lives (Kumar et al., 2024). Decision making in SSI requires students to think scientifically, this can empower science literacy skills that can be accounted for (Wiyarsi et al., 2023).

The results of preliminary research  science literacy on undergraduate science education students at one of the universities in Surabaya show that students' science literacy skills have an average of 51.3 in the low category. Low science literacy skills are feared to affect students' knowledge in their undergraduate science education programme. Thus, the purpose of this study is to stimulate students with the numbered heads together cooperative model with the SSI approach to improve their science literacy skills.

## Methods

The research was conducted at one of the universities in Surabaya, with 36 participants from the science education department. The research used quantitative method. The instruments involved in this research are learning tools, questionnaires on the

implementation of learning activities, SSI-based questions, and student responses to the learning activities that have been presented.

The implementation of learning activities was observed and assessed directly by 3 observers. The assessment of the implementation of learning activities was carried out using a Likert scale with a rating scale of 1 - 4 with criteria less - very good. The following assessment criteria can be seen in Table 1 (Wardah & Nasrudin, 2020).

**Table 1.** Assessment criteria

| Score | Description |
|---|---|
| 1 | Less |
| 2 | Simply |
| 3 | Good |
| 4 | Very good |

The SSI based questions used to measure science literacy skills were 15 multiple choice questions integrated with science literacy competencies. Of the 15 SSI-based questions there are 6 invalid questions and 9 valid questions, with a Cronbach's alpha value of 0.72 which shows a value of> 0.7 with the category of reliable questions. The questions used refer to 3 science literacy competencies according to the PISA 2025 framework, these science literacy competencies include 1) explain phenomena scientifically, 2) compile, evaluate, and interpret scientific evidence, 3) research, evaluate, and use information to make decisions (OECD, 2023b).

The achievement of the results of working on SSI questions that have been done by students is then analysed with a maximum score of 100. The scores of each science literacy competency were analysed with the SPSS application involving the anova test if the data were normally distributed and the Kruskal wallis test if the data were not normally distributed to determine whether there were differences before and after the use of the cooperative learning model of the numbered heads together type with the SSI approach. The category of score achievement of the results of working on SSI questions by students is adjusted to the assessment category in the following Table 2 (Dinata et al., 2024).

**Table 2.** Score interpretation

| Score | Category |
|---|---|
| $80 \leq N \leq 100$ | Very good |
| $66 \leq N \leq 79$ | Good |
| $56 \leq N \leq 65$ | Simply |
| $40 \leq N \leq 55$ | Low |
| $N \leq 39$ | Very low |

Furthermore, to determine the level or level of change in student scores, N-Gain analysis was conducted. N-Gain analysis was conducted to determine the level of change before and after learning that can affect students' science literacy skills. The N-Gain Score criteria are as follows Table 3(Ariyansah et al., 2021).

**Table 3.** N-gain criteria

| N-Gain Value | Category |
|---|---|
| N-gain ≥ 0.7 | High |
| 0.3 ≤ N-Gain < 0.7 | Medium |
| N-Gain < 0.3 | Low |

Regarding student responses, the response assessment was given to 36 students in Science Education 2024 by asking several questions about the learning activities that had been presented. The responses given were related to cognitive aspects, affective aspects, psychomotor aspects, and social aspects. The assessment was carried out using a Likert scale of 1 - 5 with the criteria not good to very good as shown in Table 4 (Haeriyah et al., 2023).

**Table 4**. Student response criteria

| Score | Student Response (%) | Description |
|---|---|---|
| 1 | P < 50 | Not good |
| 2 | 50 ≤ P ≤ 59 | Less good |
| 3 | 60 ≤ P ≤ 69 | Good enough |
| 4 | 70 ≤ P ≤ 79 | Good |
| 5 | P ≥ 80 | Very good |

The formula used to manage data on student response results that have been given using the following formula.

$$P = \frac{\sum n}{\sum m} \times 100\% \qquad (1)$$

Description :
P = Students response (%)
∑n = Number of scores obtained
∑m = Maximum number of scores

## Results and Discussion

The implementation of learning activities with the numbered heads together cooperative model based on SSI was carried out for 2 meetings involving 3 observers at each meeting. The activities presented refer to the learning syntax of the numbered heads together cooperative model. Learning activities refer to 3 important activities in learning, namely introductory activities, core activities, and closing activities. The core activities contain 6 phases that exist in the numbered heads together cooperative model, namely phase 1 present goals and sets, phase 2 present information, phase 3 organise students into learning teams, phase 4 assist team work and study, phase 5 test on the materials, and phase 6 provide recognition (Nurwadani et al., 2021). The following are Tables 5 and 6 of the results of observations by 3 observers related to the implementation of learning activities.

**Table 5.** Implementation of learning meeting I

| Syntax | Rating Scale | | |
|---|---|---|---|
| | Observer 1 | Observer 2 | Observer 3 |
| Preliminary Activity | 4 | 4 | 3 |
| Core Activities | 4 | 4 | 3 |
| Closing Activities | 4 | 3 | 3 |
| Modus | 4 | 4 | 3 |
| Implementation Modus | | 4 | |
| Description | | Very good | |

**Table 6.** Learning implementation of meeting II

| Syntax | Rating Scale | | |
|---|---|---|---|
| | Observer 1 | Observer 2 | Observer 3 |
| Preliminary Activity | 4 | 3 | 4 |
| Core Activities | 4 | 4 | 4 |
| Closing Activities | 3 | 3 | 3 |
| Modus | 4 | 3 | 4 |
| Implementation Modus | | 4 | |
| Description | | Very good | |

Based on the results of the assessment given by the 3 observers, it is known that the results of the assessment of the implementation of learning activities at meetings 1 and 2 were 4 in the very good category. The learning process was carried out in accordance with the learning syntax, each student from each group had done good cooperation. This is expected to improve their understanding in the discussion of environmental material.

Through the results of the implementation of learning activities in the very good category, it shows that the learning activities presented are in accordance with the provisions of the numbered heads together cooperative model. The numbered heads together cooperative model has the characteristics of a learning process that emphasises the process of cooperation in groups, the goal to be achieved is not only academic ability, but for cooperation in mastering the material (Hasanah & Himami, 2021). In detail, there are 3 main objectives in the numbered heads together cooperative model, namely learning outcomes, acceptance of differences between individuals, and development of social skills (Wardah & Nasrudin, 2020).

**Science Literacy Skills**

Regarding the achievement of science literacy scores in students, it is known that the average student pre-test score is 51.3 which shows a low category. In detail, science literacy skills in the competency of explaining scientific phenomena received an average score of 47 in the low category. In the competency of compiling, evaluating, and interpreting scientific evidence, the average score was 46 in the low category. Meanwhile, the competency to research, evaluate, and use information to make decisions received an average score of 61 in the moderate category.

The low level of students' science literacy skills as measured by SSI based questions can be caused by the unaccustomed students in working on contextual-based questions around them. As can be seen that the literacy questions tested in PISA are applicative questions that are not only related to questions of understanding concepts, but require students to be able to have critical and creative thinking skills in solving problems (Putri, 2021). Thus, it is possible that students' unfamiliarity with contextual questions based on SSI

is the cause of the low achievement of the scores of working on questions based on the given science literacy skills.

SSI are closely related to science literacy. SSI mostly contains issues that are debated about science and its use, encouraging a person to use informal reasoning and argumentation skills, conceptualise the nature of science, evaluate all information, to be able to achieve conceptual understanding is seen as a component of science literacy (Wiyarsi et al., 2023). SSI includes controversial social issues related to science, has no direct solution and requires various considerations such as moral, ethical, traditional, cultural, economic, political, and environmental (Kumar et al., 2024).

Nowadays, there are many environmental problems caused by irresponsible human behaviour. Environmental pollution events that often appear today show that the condition of the surrounding environment is not okay. Thus, environmental education is one of the solutions to optimise environmental improvement and development for a healthy and balanced society (Miyasaka & Honda, 2024). With good literacy skills, students can be one of the pioneers in overcoming existing environmental pollution.

Through the numbered heads together cooperative model based on SSI, researchers tried to optimise science literacy-based learning. Based on the results of the post-test conducted after learning activities. The post-test results showed the average student score of 73 in the good category. In detail, science literacy skills in the competency of explaining scientific phenomena get an average score of 74 in the good category. In the competency of compiling, evaluating, and interpreting scientific evidence, the average score was 68 in the good category. Furthermore, the competency to research, evaluate, and use information to make decisions received an average score of 78 in the good category.

Based on the SPSS test by conducting a non-parametric test (Wilcoxon) because the data is not normally distributed, the significance of 0.00 < 0.05 shows that there is a significant difference between the pre-test and post-test. In general, the difference in pre-test and post-test scores of 36 students can be seen in Figure 1.

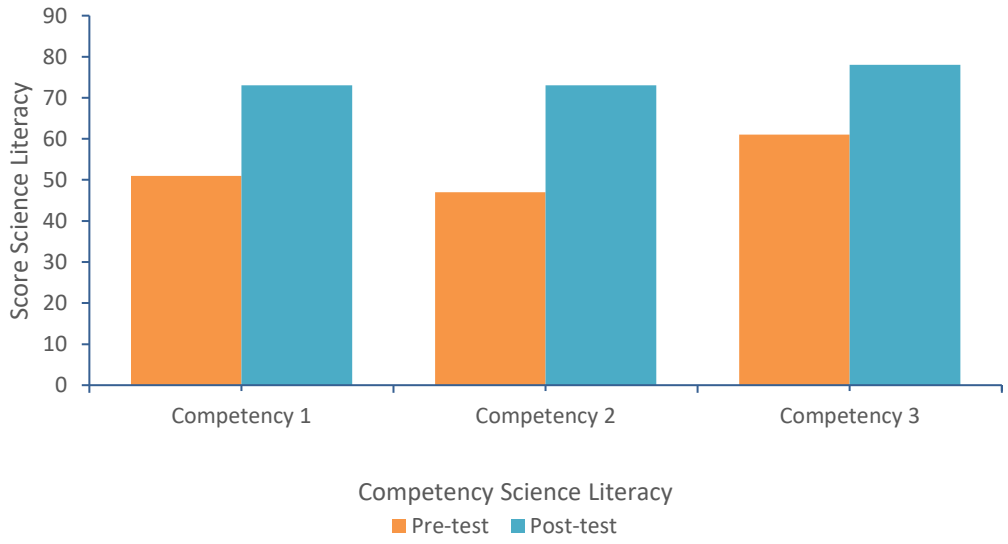


**Figure 1.** Science literacy pre-test and post-test scores

Based on the pre-test and post-test achievement scores, the majority of students experienced an increase in scores. However, based on the data, there were students who experienced a decrease in scores. In addition, there were also students who did not experience an increase in score. In detail, the achievement of the increase in student science literacy scores on each competency can be seen in Figures 2, 3, and 4.

**Competency 1 (Explaining Science Phenomena)**

In competency 1, namely explaining science phenomena, of the 15 questions that have integrated science literacy skills, there are 5 questions that measure science literacy skills with the competency of explaining science phenomena. The average score of students' pre test on this competency was 47 with a low category. Through the use of the numbered heads together cooperative learning model based on SSI on the topic of ecology, students experienced an increase in the average score of 74 in the good category. The following in Figure 2, is a representation of the score increase, decrease, or no change in student scores before and after learning.

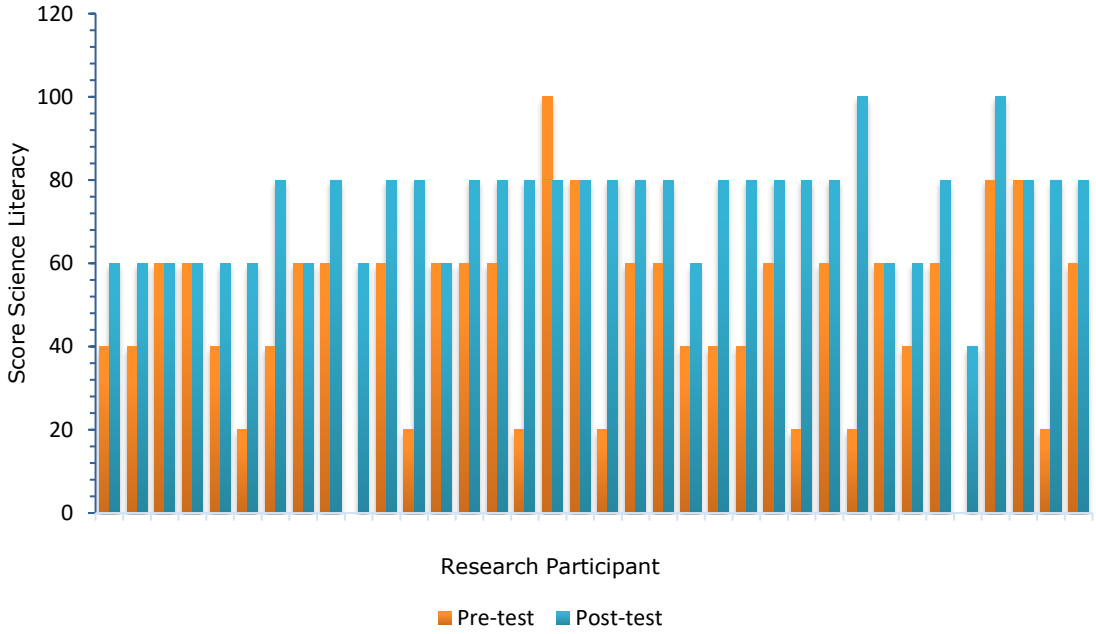


**Figure 2.** Pre-test and post-test scores competency explaining science phenomena

The aspect of explaining scientific phenomena measures students' conceptual understanding of a material. Through science literacy skills in this competency, students can use the knowledge they have to understand the phenomena around them scientifically. Science literacy skills in this competency support students to understand that science is very close to their lives (Mellyzar et al., 2022).

**Competency 2 (Compiling, Evaluating and Interpreting Scientific Evidence)**

In competency 2, namely compiling, evaluating, and interpreting scientific evidence, of the 15 questions that have integrated science literacy skills, there are 5 questions that measure science literacy skills with these competencies. The average score of students' pre-test on these competencies was 46 with a low category. Through the use of the numbered heads together cooperative learning model based on SSI on the topic of ecology, students experienced an increase in the average score of 68 in the good category. The following in Figure 2, is a representation of the score increase, decrease, or no change in student scores before and after learning.

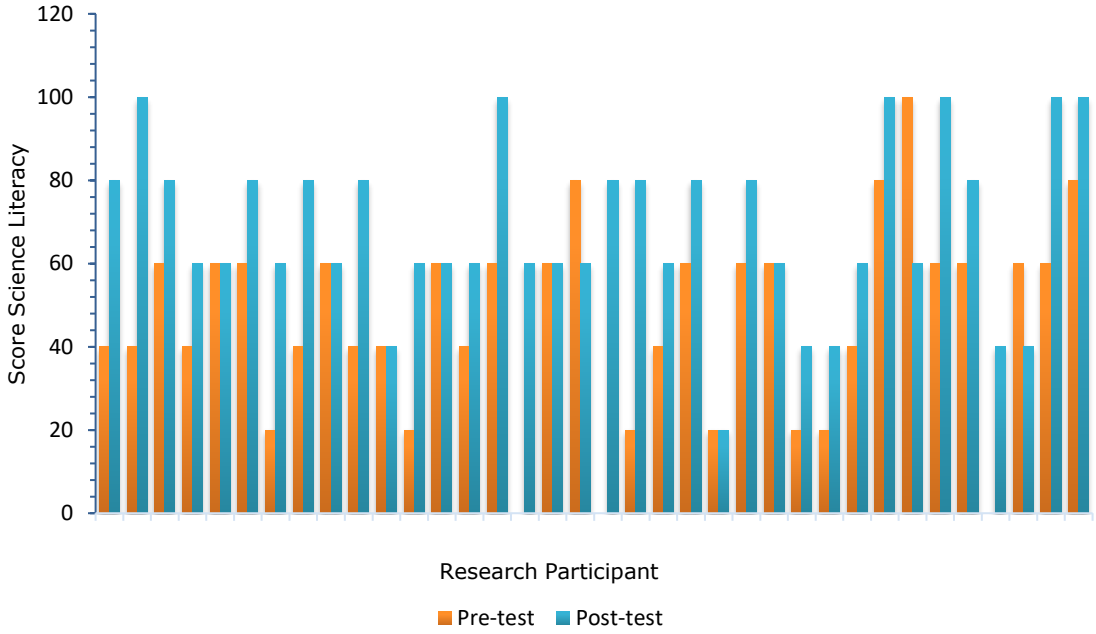


**Figure 3.** Pre-test and post-test scores of competence in compiling, evaluating, and interpreting scientific evidence

The competency aspect of compiling, evaluating and interpreting scientific evidence in science literacy skills encourages students' ability to describe the scientific evidence they find. Through the scientific evidence found, students will have more understanding. This competency helps students to make conclusions about natural phenomena in their environment due to human activities or other living things (Noviana, M. & Julianto, 2017).

**Competency 3 (Researching, Evaluating, and Using Information to Make Decisions)**

In competency 3, namely the competence of researching, evaluating, and using information to make decisions, of the 15 questions that have integrated science literacy skills, there are 5 questions that measure science literacy skills with these competencies. The average score of students' pre-test on these competencies was 61 with a simply category. Through the use of the numbered heads together cooperative learning model based on SSI on the topic of ecology, students experienced an increase in the average score of 78 in the good category. The following in Figure 4, is a representation of the score increase, decrease, or no change in student scores before and after learning.

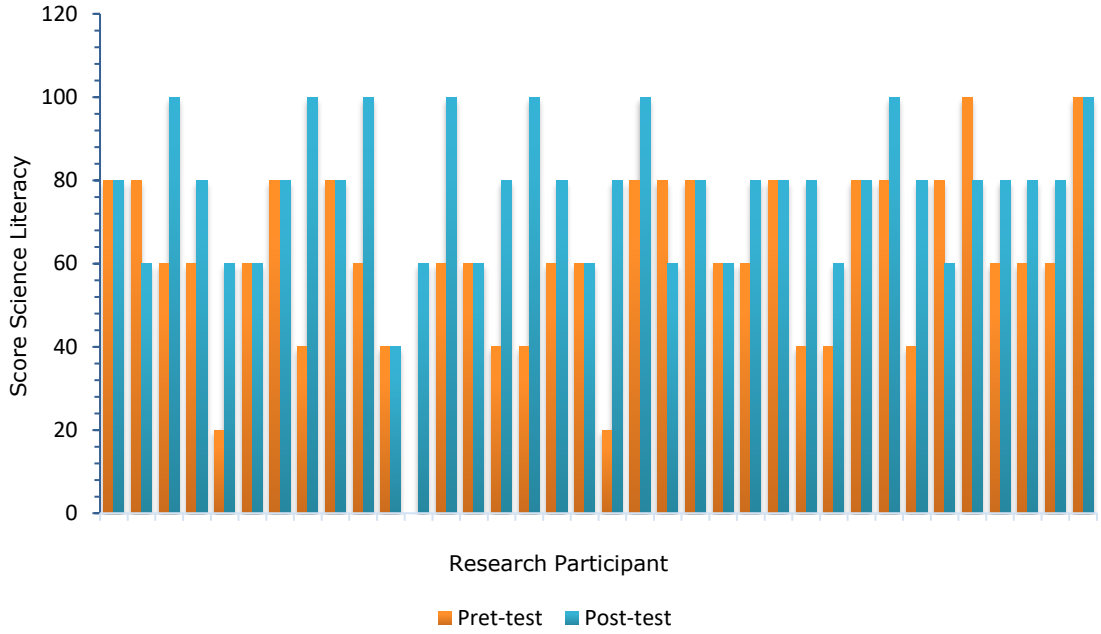


**Figure 4.** Pre-test and post-test scores of competence in researching, evaluating, and using information to make decisions

The competency aspect of researching, evaluating, and using information to make decisions is the last competency of science literacy. After being able to understand and explain scientific phenomena supported by the ability to describe existing scientific evidence, students are directed to determine the right decision to respond to environmental phenomena related to science around them. The importance of science literacy skills that can support understanding of science concepts and processes allows a person to make decisions to contribute to the growth of the country (Hasnawati et al., 2024).

Analysis of the improvement of science literacy skills was tested by conducting N-Gain analysis. N-Gain analysis aims to determine the improvement of student learning outcomes (Mutmainnah et al., 2021). Based on the N-Gain analysis through the results of the pre-test and post-test scores, it is known that the mean value of the N-Gain score is 0.45 with a moderate category. N-Gain analysis on each science literacy competency also showed significant changes. The N-Gain analysis on each indicator presented in Table 7.

**Table 7.** N-gain score analysis of each science literacy competency

| Science Literacy Skills | Average Score | | N-Gain Score | Description |
|---|---|---|---|---|
| | *Pre-test* | *Post-test* | | |
| Explaining science phenomena | 47 | 74 | 0.51 | Medium |
| Collate, evaluate and interpret scientific evidence | 46 | 68 | 0.41 | Medium |
| Research, evaluate and use information to make decisions | 61 | 78 | 0.44 | Medium |

From each competency, science literacy skills experienced changes in the moderate category. Thus, it can be concluded that the use of cooperative model of numbered heads together type with SSI approach can affect the science literacy skills of undergraduate Science Education students in the moderate category. The achievement of the scores obtained by the students certainly shows the success of using the cooperative model of numbered heads together based on SSI in influencing students' science literacy skills.

**Student Response to Learning**

Students as the research sample responded to the learning activities that had been presented. A total of 36 students responded through the questionnaire that had been given. Student responses are student responses to the learning activities presented. The responses given contain 4 important aspects, including cognitive, affective, psychomotor, and social aspects.

The cognitive aspect is related to the learning process that can affect the critical thinking process (Wati & Fatimah, 2016). Affective aspects are related to a person's attitude or encouragement in learning activities such as paying attention, responding, or appreciating. While the psychomotor aspect is related to how students can control their activities (Zabidi et al., 2024). Social aspects are directly related to students' interactions with their surroundings, such as their interactions with other students in learning activities (Sinaga & Choiriyah, 2023). The purpose of this student response is to find out student responses regarding the learning that has been presented and later can be used as an evaluation for the future. The following in Table 8 is the result of student response analysis.

**Table 8.** Student response to learning activities

| Assessment Indicator | Student Response (%) | Description |
|---|---|---|
| Cognitive aspects | 92 | Very good |
| Affective aspects | 91 | Very good |
| Psychomotor aspects | 91 | Very good |
| Social aspects | 92 | Very good |
| Average | 92 | Very good |

Based on the results of the student response analysis, it shows very good results. Students gave a positive assessment of the cognitive, affective, psychomotor, and social aspects that were internalised in the learning activities that had been presented. The average assessment of student responses to the learning activities that have been presented has a percentage of 92% in the very good category. It is known that based on relevant research, learning with the cooperative model of numbered heads together can improve social interaction and cooperation between students to achieve academic understanding (Astutik & Wulandari, 2020).

The integration of the SSI approach in the numbered heads together cooperative learning model that involves scientific social issues that can be found in everyday life trains students to develop solutions to these phenomena, not only based on scientific dimensions but also social consequences. This has proven to be effective in developing science literacy (Ke et al., 2021). The involvement of scientific topics in the SSI approach that are controversial requires students to be actively involved in the discussion. Topics included in SSI require moral reasoning in decision making (Mamutse, 2024). Thus, students can be trained to be able to provide solutions in making decisions that can be justified

## Conclusion

Learning activities carried out during the two meetings received good assessments from the three observers. Student responses to the learning activities that have been presented get a response with a very good category which shows an average percentage of 92%. In relation to the objectives of the research conducted, it is known that the use of the numbered heads together cooperative learning model with the SSI approach can improve science literacy skills. This is based on the Wilcoxon test which shows a significance of 0.00 <0.05 which indicates a change, as well as N-Gain analysis which shows an increase in the moderate category.

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