EFFECTIVENESS OF THE CONNECTED LEARNING CYCLE (CLC) FOR TRAINING SCIENTIFIC LITERACY SKILLS AND ARGUMENTATION SKILLS IN PROSPECTIVE CHEMISTRY TEACHER STUDENTS

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ABSTRACT

Objective: This research aims to determine the use of connected learning cycle (CLC) to practice scientific literacy skills and argumentation skills.

Theoretical Framework: Connected learning cycle is a learning strategy using a connected curricular model combined with the 5E learning cycle. There is a relationship between scientific literacy skills and argumentation. Argumentation skills can be improved with literacy skills.

Method: This study used a single group pretest post-test research design. The tools and instruments used to collect data have been validated by five experts and received a very valid assessment in the content and construct aspects. The research instruments include scientific literacy and argumentation skills test questions, student activity observation sheets, and student response questionnaires. The analysis used includes learning completeness, in this case completeness in scientific literacy skills, argumentation skills, the n-gain score to see the development of learning outcomes. The Chi square test, and the Fisher test looked at the relationship between scientific literacy and argumentation skills.

Results and Discussion: Connected Learning Cycle (CLC) method is effective for training scientific literacy and argumentation skills.

Research Implications: Remembering literacy and argumentation skills is the basis for developing other thinking skills, it is hoped that the results of this research can be used as an alternative effort to train scientific literacy skills and argumentation skills.

Originality/Value: The Connected Learning Cycle (CLC) method used was a combination of connected curricular model combined with the 5E learning cycle as alternative effort to train scientific literacy skills and argumentation skills.

Keywords: Connected Learning Cycle (CLC), Scientific Literacy Skills, Argumentation Skills, Effectiveness.

EFICÁCIA DO CICLO DE APRENDIZAGEM CONECTADA (CLC) PARA TREINAMENTO DE HABILIDADES DE ALFABETIZAÇÃO CIENTÍFICA E HABILIDADES DE ARGUMENTAÇÃO EM PROSPECTIVOS ALUNOS PROFESSORES DE QUÍMICA

RESUMO

Objetivo: Esta pesquisa tem como objetivo determinar o uso do ciclo de aprendizagem conectado (CLC) para praticar habilidades de alfabetização científica e habilidades de argumentação.

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Referencial Teórico: O ciclo de aprendizagem conectado é uma estratégia de aprendizagem que utiliza um modelo curricular conectado combinado com o ciclo de aprendizagem 5E. Existe uma relação entre habilidades de alfabetização científica e argumentação. As habilidades de argumentação podem ser melhoradas com habilidades de alfabetização.

Método: Este estudo utilizou um projeto de pesquisa pré-teste pós-teste de grupo único. As ferramentas e instrumentos utilizados para coleta de dados foram validados por cinco especialistas e receberam avaliação muito válida nos aspectos de conteúdo e construção. Os instrumentos de pesquisa incluem questões de teste de alfabetização científica e habilidades de argumentação, fichas de observação de atividades dos alunos e questionários de respostas dos alunos. A análise utilizada inclui a integralidade da aprendizagem, neste caso a integralidade nas competências de literacia científica, competências de argumentação, a pontuação n-ganho para ver o desenvolvimento dos resultados da aprendizagem. O teste Qui-quadrado e o teste de Fisher analisaram a relação entre alfabetização científica e habilidades de argumentação.

Resultados e Discussão: O método Connected Learning Cycle (CLC) é eficaz para treinar alfabetização científica e habilidades de argumentação.

Implicações da Pesquisa: Lembrando que as competências de literacia e argumentação são a base para o desenvolvimento de outras competências de pensamento, espera-se que os resultados desta investigação possam ser utilizados como um esforço alternativo para treinar competências de literacia científica e de argumentação.

Originalidade/Valor: O método do Ciclo de Aprendizagem Conectado (CLC) utilizado foi uma combinação do modelo curricular conectado combinado com o ciclo de aprendizagem 5E como esforço alternativo para treinar habilidades de alfabetização científica e habilidades de argumentação.

Palavras-chave: Ciclo de Aprendizagem Conectada, Habilidades de Alfabetização Científica, Habilidades de Argumentação, Eficácia.

EFECTIVIDAD DEL CICLO DE APRENDIZAJE CONECTADO (CLC) PARA LA FORMACIÓN DE HABILIDADES DE ALFABETIZACIÓN CIENTÍFICA Y DE ARGUMENTACIÓN EN FUTUROS ESTUDIANTES DE PROFESORÍA DE QUÍMICA

RESUMEN

Objetivo: Esta investigación tiene como objetivo determinar el uso del ciclo de aprendizaje conectado (CLC) para practicar habilidades de alfabetización científica y habilidades de argumentación.

Marco Teórico: El ciclo de aprendizaje conectado es una estrategia de aprendizaje que utiliza un modelo curricular conectado combinado con el ciclo de aprendizaje 5E. Existe una relación entre las habilidades de alfabetización científica y la argumentación. Las habilidades de argumentación se pueden mejorar con habilidades de alfabetización.

Método: Este estudio utilizó un diseño de investigación de prueba previa y posterior a la prueba de un solo grupo. Las herramientas e instrumentos utilizados para la recogida de datos han sido validados por cinco expertos y recibieron una valoración muy válida en los aspectos de contenido y construcción. Los instrumentos de investigación incluyen preguntas de prueba de alfabetización científica y habilidades de argumentación, hojas de observación de actividades de los estudiantes y cuestionarios de respuesta de los estudiantes. El análisis utilizado incluye la integridad del aprendizaje, en este caso la integridad de las habilidades de alfabetización científica, las habilidades de argumentación y la puntuación n-gain para ver el desarrollo de los resultados del aprendizaje. La prueba de Chi cuadrado y la prueba de Fisher analizaron la relación entre la alfabetización científica y las habilidades de argumentación.

Resultados y Discusión: El método Connected Learning Cycle (CLC) es eficaz para entrenar la alfabetización científica y las habilidades de argumentación.

Implicaciones de la investigación: Recordar que la alfabetización y las habilidades de argumentación es la base para desarrollar otras habilidades de pensamiento, se espera que los resultados de esta investigación puedan usarse como un esfuerzo alternativo para entrenar habilidades de alfabetización científica y habilidades de argumentación.
1 INTRODUCTION

Based on the results of previous research, shows that students' argumentation abilities are still low to moderate, and the majority are at level 2 (Rusmini et al., 2021). The argumentation skills in question follow the TAP (Toulmin argumentation Pattern) (Aslan, 2019; Erduran et al., 2004; Toulmin et al., 1984). Currently, efforts are being developed to achieve argumentation skills. This is related to the number of social issues and scientific conflicts that require reliable evidence before making decisions (Pimvichai et al., 2019). Therefore, this ability must certainly be improved. Argumentation skills are a person's ability to formulate, organize and present effective and persuasive opinions to convince other people about a particular opinion (Ekanara et al., 2018). According to Partnership for 21st Century Skills (P21), argumentation will encourage someone to be communicative, think critically, creatively and solve problems which are included in 21st-century skills (Nakano & Wechsler, 2018). Argumentation skills are related to critical thinking and communication skills which are also part of the 21st-century skills that must be mastered by students (Hasnunidah et al., 2020; Karadeniz, 2016; Roviati & Widodo, 2019).

These argumentation skills can be improved with literacy skills (Belland & Kim, 2021). Three types of literacy can be used to improve argumentation skills, namely reading literacy, numeracy literacy and scientific literacy (Rahmadanita, 2022; Irfansyah, 2021). Scientific literacy is the ability to use scientific knowledge, identify questions, interpret scientific information, and draw conclusions based on evidence, to understand and make decisions regarding nature and natural changes through human activities in daily life (Ad’hiya & Laksono, 2018; Rahayu, 2017; Turiman et al., 2012). Scientific literacy is also stated in OECD (2015), as the ability to connect issues or problems related to science, and ideas in science. Handayani et al. (2018) and Meldawati (2017) said literacy skills help students access and manage the information needed to compose quality arguments in facing complex global
challenges. Scientific information helps individuals construct arguments that are supported by strong and valid evidence. One of the factors that influences literacy skills is the ability to think critically (Kim, 2019). By building a literacy culture, students can improve critical thinking (Aiman et al., 2020; Sutiani, 2021; Yasdin et al., 2021). Argumentation ability is related to critical thinking (Hasnunidah et al., 2020; Meral et al., 2021; Osborne et al., 2016). Thus, the better the literacy, the better the students' arguments.

However, Indonesian literacy is very low. UNESCO said Indonesia is second from the bottom in terms of world literacy, meaning interest in reading is very low. According to UNESCO data, Indonesian people's interest in reading is very worrying, only 0.001%. This means that out of 1,000 Indonesians, only 1 person reads diligently (Devege, 2017). Data from PISA shows the low literacy skills of students in Indonesia. Data from a survey conducted by the Program for International Student Assessment (PISA) which was released by the Organization for Economic Co-operation and Development (OECD) in 2019, shows that Indonesia is ranked 62nd out of 70 countries, meaning that Indonesia in the bottom 10 countries with a level of low literacy (Ilham, 2022; Muzayanah et al., 2023; Rahmadanita, 2022). The results of diagnostic tests conducted by researchers showed that the average student's scientific literacy ability was 57.2. This value is still below individual and classical completeness. On the other hand, the government has tried to improve students' literacy skills with the Indonesian national assessment program. The national assessment in Asesmen Kompetensi Minimum (2022) has determined literacy as a skill ability that is assessed in the minimum competency assessment.

Considering the importance of literacy skills and argumentation, it is necessary to strengthen these two skills. The effort made is to implement thinking skills training with a connected learning cycle (CLC) strategy. A connected learning cycle is a learning strategy using a connected curricular model combined with the 5E learning cycle. The connected curricular model is part of integrated learning, namely to link topics, concepts, and skills, in this case, thinking skills (Fogarty & Pete, 2009). The connected curricular model is used to link several parts of the material into one integrated and interrelated unit so that students can absorb information completely and increase their creativity to create new knowledge according to their abilities. The thematic connected model can increase knowledge and skills (Chamisijatin et al., 2022).

The 5E learning cycle in Bybee (2015) and Kazempour et al. (2020) has five stages, namely Engagement, Exploration, Explanation, Elaboration, and Evaluation. Engagement is linking lessons with everyday knowledge and experience. This stage aims to arouse interest,
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arouse curiosity, attract students' attention, and prepare students for further learning (Bybee, 2015; Kazempour et al., 2020; Mulyeni et al., 2019; Weng et al., 2022). At this stage, motivation and apperception provided are given by the lecturer. At this stage, motivation and apperception are provided. In this CLC, the engagement stage was used as a connected stage, namely connecting literacy skills and argumentation as a form of apperception. Students are reminded again about the material on scientific literacy skills and the relationship between scientific literacy skills and argumentation as a connected form of this CLC pattern.

Exploration is a stage in exploring the topic of discussion in more depth. Exploratory experiences should be designed for the subsequent introduction and description of concepts and skills of the learning sequence (Bybee, 2015; Kazempour et al., 2020; Mulyeni et al., 2019; Weng et al., 2022). Students are given the opportunity to explore the material being trained, namely scientific literacy skills and argumentation skills. Students are guided to observe, study and reconstruct their understanding, formulate explanations, investigate phenomena, discuss ideas, and develop cognitive abilities (Bybee, 2015; Kazempour et al., 2020). In CLC, this exploration stage is carried out through understanding phenomena, understanding example questions and discussing example questions in each student worksheet.

Explanation is a stage where students explain what they have learned in their own words (Bybee, 2015; Kazempour et al., 2020; Weng et al., 2022). In this CLC, explanation activities are carried out with students explaining what they have understood from student worksheets, namely explaining scientific literacy skills and argumentation skills. Elaboration is the fourth stage of 5E. At this stage, students are given the opportunity to apply their understanding to new contexts, express ideas, receive input from friends, and solve problems regarding new topics (Bybee, 2015; Kazempour et al., 2020). This stage was carried out by giving students the opportunity to work on practice questions in LKM as a development of the skills demonstrated in the previous stage. Evaluation measures understanding. Evaluation can also be carried out using written tests or assessing student activities through observation (Bybee, 2015; Kazempour et al., 2020; Weng et al., 2022). In this CLC, the evaluation stage is used to post-test scientific literacy skills and argumentation skills.

Learning cycle 5E (LC5E) was chosen as connected because this learning emphasizes direct experience, reflection, and developing deep understanding through student actions. This approach supports active, student–centered learning. LC5E can be used to develop thinking skills by applying knowledge to real-world contexts. Therefore, this research wants to find out how students' literacy and argumentation skills are implemented by implementing the
connected learning cycle. This research is important to carry out as an effort to improve students' literacy skills as a basis for argumentation skills facing the 21st century.

2 METHOD

This study used a single group pretest post-test research design, meaning that just one test class completed a pretest prior to treatment and a post-test at the conclusion of the activity. This design is included in the pre-experimental design. With pre-experimental designs, the researcher studies a single group and provides an intervention during the experiment. This design does not have a control group to compare with the experimental group (Creswell & Creswell, 2015; Fraenkel et al., 2012; Sugiyono, 2011). Pre-experiments are a more useful method than one-shot case studies for assessing the impact and effectiveness of treatments administered to samples by researchers (Jamal et al., 2019). The sample used was one class of 24 students in the fourth semester of the chemistry education study program. The tools and instruments used to collect data have been validated by five experts and received a very valid assessment in the content and construct aspects. The tools used include a scientific literacy worksheet, a connected scientific literacy and argumentation worksheet, and an argumentation skills worksheet. The research instruments include scientific literacy skills test questions, argumentation skills test questions, student activity observation sheets, and student response questionnaires regarding the implementation of CLC. This research data was in the form of test results for scientific literacy skills and argumentation skills. The data is supported by data from student response questionnaires regarding CLC learning, the results of observations of the implementation of training data, and student activities while participating in CLC. The analysis used includes learning completeness, in this case completeness in scientific literacy skills, argumentation skills, the n-gain score to see the development of learning outcomes (Hake, 1998). The Chi square test, and the Fisher test using IBM SPSS Statistics 21 for Windows, looked at the relationship between scientific literacy skills and argumentation (Witte & Witte, 2017).

Learning was carried out twice, face-to-face, for 3 hours each, from pretest to posttest. The first meeting carried out learning using learning cycle 5E (LC5E). The engagement stage contains motivation related to the importance of learning scientific literacy and argumentation skills. Providing motivation aims to increase students’ interest and curiosity about the skills to be performed. Teachers can motivate students by providing opportunities for them to learn independently, construct experiences, and develop skills and future benefits. This stage is an
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important one in learning because it influences student readiness (Ismail & Abdulla, 2019; Slavin, 2011). The exploration stage was carried out by exploring phenomena in example questions along with answering questions presented on student worksheets. The explanation stage means students explain what has been understood about scientific literacy skills. The elaboration stage was carried out by developing self-understanding by doing practice questions and explaining what had been understood. Finally, the evaluation stage involved carrying out a post-test on scientific literacy skills.

At the second meeting, literacy skills were connected with argumentation. Connected is placed in the engagement stage. Engagement is an activity that aims to link lessons with everyday knowledge and experience. The aim of this stage is to arouse interest, arouse curiosity, attract students' attention, and prepare students for further learning (Bybee, 2015; Mulyeni et al., 2019). The engagement stage at the second meeting discussed the same or equivalent indicators between scientific literacy and argumentation skills. The intersecting indicators are the competency domain and the knowledge domain of scientific literacy skills, with warrant and backing from Toulmin's argumentation. At this engagement stage, exploration, explanation, and elaboration stages were also carried out. As in the first meeting, we start by exploring the phenomenon, explaining the relationship between literacy science skills and argumentation skills, developing self-understanding by doing practice questions, and explaining what you have understood. This stage is an important part of the connected learning cycle. Connected learning is a form of integrated learning between these two skills. This is what characterizes CLC (connected learning cycle), namely that there is a link between two skills or two topics. In this connected cycle, no post-test is carried out. An overview of connected science literacy and argumentation skills is presented in Figure 1.

Figure 1

*Figure 1
Connected Learning Cycle Pattern of Scientific Literacy Skills and Argumentation Skills*

Source: Prepared by authors.

The following is an explanation of Figure 1. The first large circle represents the first
meeting to discuss scientific literacy skills using the 5E stages. The second circle was an activity to practice argumentation skills, starting with a connection at stage E1, which presents the same or equivalent indicator intersection between scientific literacy skills and argumentation skills. The intersection of these indicators also needs to be understood so that steps E2, E3, and E4 are carried out. After stage E1 at the second meeting was completed, it continued with stages E2 to E5 by evaluating the results of learning argumentation skills. When more than one skill is combined and connected in a directed way, this can increase students’ inquiry and curiosity and make learning relevant and connected (Krogh & Morehouse, 2014). Repetition stages E2 to E4 in the connected section will trigger a better understanding of the two skills being trained due to repetition. Repetition functions to transfer information in sequence from short-term memory to a stable long-term memory representation through repeated exposure or repetition (Henry et al., 2022; Attout et al., 2020).

3 RESULTS AND DISCUSSIONS

In this section, the research results and data analysis are presented. Data analysis is presented in four sections: mastery learning, development of learning outcomes, analysis of the relationship between thinking skills, observation results of learning implementation, and questionnaire response results

3.1 MASTERY LEARNING

Mastery learning is the minimal degree of competency in attitudes, knowledge, and skills, as defined by the Minister of Education and Culture's Regulation Number 104 of 2014 in Article 1. This includes full mastery of the subject matter and completion of learning during the learning period (Kemendikbud, 2014). In this instance, the outcomes of scientific literacy and argumentation skills demonstrate the totality of thinking abilities, which represents the mastery of learning. Completeness scores on the test were 91.7% and 87.5%, respectively. The outcome has above the classical mastery learning 85% threshold (Trianto, 2009).

Implementing CLC can improve learning outcomes because CLC can activate students in learning. Students' active participation in the learning process through the stages of exploration, explanation, and elaboration results in students being actively involved in developing their own understanding. If students play an active role in learning activities, they will gain a positive perception of learning objectives and achieve higher learning outcomes.
(Park et al., 2019) The engagement stage makes it easy for students to connect the skills to be trained with contextual problems encountered in everyday life. Contextual learning makes experiences and learning meaningful so that it can increase students' understanding (Kristiantari et al., 2023; Rijal, 2021). The implementation of connected means there is a link between concepts, in this case, scientific literacy skills and argumentation skills. This can help understand how related skills can be interacted with in a broader context.

3.2 DEVELOPMENT OF LEARNING OUTCOMES

This research uses a one-group pretest-posttest design. The pretest and posttest were used to analyze the development of student learning outcomes after being given treatment in the form of applying CLC for scientific literacy skills and argumentation skills. The development of learning outcomes was calculated using N-gain. N-gain was calculated by the formula.

\[
N - gain = \frac{Score_{posttest} - Score_{pretest}}{Score_{maximal} - Score_{pretest}} \quad (Hake, 1998)
\]

Table 1

<table>
<thead>
<tr>
<th>N-gain Criteria</th>
<th>N-Gain Percentage Scientific Literacy Skills</th>
<th>Argumentation Skills</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>28.57%</td>
<td>21.43%</td>
</tr>
<tr>
<td>Medium</td>
<td>71.43%</td>
<td>32.14%</td>
</tr>
<tr>
<td>High</td>
<td>0</td>
<td>46.43%</td>
</tr>
</tbody>
</table>

Source: Author (2024)

Based on the N-gain data in Table 1, everything shows positive values, meaning there is an increase in student abilities. The increase in ability seen from the n-gain score has provided good results from this thinking skills training. This shows that the training provided with CLC is able to improve students' literacy and argumentation skills.

3.3 ANALYSIS OF THE RELATIONSHIP BETWEEN THINKING SKILLS

The Chi-Square test was used to analyze the relationship between two categorical variables. The post-test scores obtained were then categorized as good and not good. Then a
connection is made between scientific literacy skills and argumentation skills. The contingency table between scientific literacy and argumentation can be seen in Table 2.

**Table 2**

*Contingency table between scientific literacy skills and argumentation skills*

<table>
<thead>
<tr>
<th></th>
<th>Argumentation Good</th>
<th>Argumentation Bad</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scientific literacy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Good</td>
<td>20</td>
<td>1</td>
<td>21</td>
</tr>
<tr>
<td>Bad</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>21</td>
<td>3</td>
<td>24</td>
</tr>
</tbody>
</table>

Source: Author (2024)

The hypothesis proposed in the Chi-square test is $H_0 = \text{There is no significant relationship between scientific literacy skills and argumentation skills;}$ $H_1 = \text{there is a significant relationship between scientific literacy skills and argumentation skills.}$ If the value of Asymp. Sig < 0.05, $H_0$ is rejected and $H_1$ is accepted. If the value of Asymp. Sig > 0.05, $H_0$ is accepted and $H_1$ is rejected. The data presented in Table 2 are used for Chi square analysis and the results obtained are as in Table 3.

**Table 3**

*Result of Chi Square Test and Fisher's Test*

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
<th>df</th>
<th>Asymp. Sig. (2-sided)</th>
<th>Exact Sig. (2-sided)</th>
<th>Exact Sig. (1-sided)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Chi-Square</td>
<td>9.197a</td>
<td>1</td>
<td>.002</td>
<td>.003</td>
<td>.032</td>
</tr>
<tr>
<td>Continuity Correctionb</td>
<td>4.408</td>
<td>1</td>
<td>.036</td>
<td>.036</td>
<td>.036</td>
</tr>
<tr>
<td>Likelihood Ratio</td>
<td>6.225</td>
<td>1</td>
<td>.013</td>
<td>.032</td>
<td>.032</td>
</tr>
<tr>
<td>Fisher's exact Test</td>
<td></td>
<td></td>
<td></td>
<td>.032</td>
<td>.032</td>
</tr>
<tr>
<td>Linear-by-Linear Association</td>
<td>8,814</td>
<td>1</td>
<td>.003</td>
<td>.032</td>
<td>.032</td>
</tr>
<tr>
<td>N of Valid Cases</td>
<td>24</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Author (2024)

Based on the data in Table 3, the Asymp value is known. The sig on Pearson Chi-Square is 0.002, so <0.05 means $H_0$ is rejected and $H_1$ is accepted. So there is a significant relationship between scientific literacy skills and argumentation skills. In Table 3, there is also a sig value from Fisher's test of 0.032, which is smaller than 0.05, meaning there is a significant relationship between science literacy skills and argumentation skills. These results are supported by other research that shows there is a significant relationship between scientific literacy skills and argumentation (Belland & Kim, 2021; Kim et al., 2022; Cankava & Aydogan, 2022; Fakhriyah et al., 2022). Students will be able to argue well if they are supported by good knowledge. Knowledge is one of the domains of scientific literacy.
3.4 OBSERVATION RESULT OF CLC IMPLEMENTATION

To make sure that all of the scheduled measures have been carried out, the CLC’s implementation was observed. Four observers were present during the activities. Table 4 displays the findings from the observations of CLC implementation.

### Table 4

**Observation Result of CLC Implementation**

<table>
<thead>
<tr>
<th>Observation Item</th>
<th>Observation Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Syntax Implementation</td>
<td>100% of the syntax has been implemented properly</td>
</tr>
<tr>
<td>Timeliness of implementation</td>
<td>81.25% is as planned</td>
</tr>
<tr>
<td>Material presented</td>
<td>100% in accordance with the training material</td>
</tr>
<tr>
<td>Implementation method</td>
<td>81.25% have been implemented well</td>
</tr>
<tr>
<td>General conclusion</td>
<td>81.25% carried out well</td>
</tr>
</tbody>
</table>

Source: Author (2024)

CLC is able to strengthen the interconnection of concepts and improve high-level thinking skills among students. This is because cohesive knowledge is established and applied effectively in real-world contexts (Hattie & Yates, 2014). Through this CLC stage, students become more active because they are involved in demanding exploration, explanation, elaboration, and evaluation. Students participate in learning. The development of integrated and connected learning will enable critical thinking, problem solving, communication, collaboration, creativity, and innovation. This plays an important role in the lives of the younger generation. Connected also results in students feeling cared for, trusted, appreciated, and recognized in their learning environment (Todd, 2010).

3.5 RESPONSE QUESTIONNAIRE RESULTS

Student responses are used to determine student responses to learning using the CLC flow. A response questionnaire was given at the end of the CLC lesson with yes or no questions. The results of the questionnaire are presented in Table 5.
Table 5

Result of Student Responses to the Implementation of CLC

<table>
<thead>
<tr>
<th>No</th>
<th>Question Item</th>
<th>“Yes” Answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Have you received thinking skills training before this activity?</td>
<td>42.86</td>
</tr>
<tr>
<td>2</td>
<td>Do you take this thinking skills training seriously?</td>
<td>100.00</td>
</tr>
<tr>
<td>3</td>
<td>Does the lecturer explain each material well?</td>
<td>100.00</td>
</tr>
<tr>
<td>4</td>
<td>In general, does the student worksheet provided help you understand the training material?</td>
<td>100.00</td>
</tr>
<tr>
<td>5</td>
<td>Are the questions in the pretest posttest questions appropriate to the training material?</td>
<td>92.86</td>
</tr>
<tr>
<td>6</td>
<td>Do the training steps provided in accordance with your stage of thinking?</td>
<td>96.43</td>
</tr>
<tr>
<td>7</td>
<td>Is the duration of time used for each training session appropriate to the type of skill being trained?</td>
<td>82.14</td>
</tr>
<tr>
<td>8</td>
<td>Do you actively participate in this training activity?</td>
<td>96.43</td>
</tr>
<tr>
<td>9</td>
<td>After participating in this training, do you understand scientific literacy skills?</td>
<td>92.86</td>
</tr>
<tr>
<td>10</td>
<td>After attending this training, do you understand argumentation skills?</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Source: Author (2024)

The results of this questionnaire show how CLC is implemented according to students. To strengthen students’ opinions, observations were also carried out on student activities to find out whether student activities were used for learning activities or vice versa. The results of observations of student activities are presented in Table 6.

Table 6

Students' Activities Data

<table>
<thead>
<tr>
<th>No</th>
<th>Students' Activity</th>
<th>Description of student activities at meetings one and two</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Doing pretest</td>
<td>All students carried out a pretest</td>
</tr>
<tr>
<td>2</td>
<td>Listen to information from lecturers</td>
<td>All students listened well</td>
</tr>
<tr>
<td>3</td>
<td>Doing students worksheet</td>
<td>All students worked on the students worksheet according to the time given; some even started working on the students worksheet so that the students worksheet could be completed. Most students use their mobile phones to answer questions on the students worksheet.</td>
</tr>
<tr>
<td>4</td>
<td>Discuss with friends</td>
<td>Most of students helded discussions with friends sitting next to them</td>
</tr>
<tr>
<td>5</td>
<td>Convey opinions/ideas</td>
<td>A few number of students submitted answers or responded to other students’ answers</td>
</tr>
<tr>
<td>6</td>
<td>Asking question</td>
<td>No students asked questions</td>
</tr>
<tr>
<td>7</td>
<td>Answer questions from the lecturer verbally</td>
<td>A small number of students answered verbal questions</td>
</tr>
<tr>
<td>8</td>
<td>Doing posttest</td>
<td>All students did posttest</td>
</tr>
<tr>
<td>9</td>
<td>The student's position during the duration of the training</td>
<td>None of the students in the class leaved the classroom during the activity</td>
</tr>
<tr>
<td>10</td>
<td>Irrelevant activity</td>
<td>A few number of students used mobile phone outside of the material, students talked to other students outside the training topic, there were students who arrived late</td>
</tr>
</tbody>
</table>

Source: Author (2024)

Based on the data in Table 6, it shows that student activities are used for activities that support learning. This is also in accordance with the results of the response questionnaire, which
also stated that students were serious about participating in the training. If students actively participate in learning, it will improve learning outcomes (Freeman et al., 2014; Marušić & Dragojević, 2020)

The combination of connected learning cycles is able to promote meaningful, in-depth learning and involve students in developing knowledge and skills. Interrelated skills carried out through repeated cycles increase student understanding. This plays an important role considering that scientific literacy and argumentation skills are important for students to master, so training needs to be carried out and needs to be developed until maximum completeness is obtained. Argumentation skills contribute to the development of communication skills and critical thinking skills, support cognitive and metacognitive processes, develop rational reasoning, and achieve scientific literacy (Erduran & Aleixandre, 2007). This also supports the implementation of Minister of Education and Culture’s Regulation Number 3 of 2020 which states that each graduate of the undergraduate program has at least mastered theoretical concepts in certain fields of knowledge and skills in general (Kemendikbud, 2020). Graduates must also master the theoretical concepts of specialized parts in this field of knowledge and skills in depth. Scientific literacy skills and argument skills are part of those skills.

4 CONCLUSION

Using the Connected Learning Cycle (CLC) method is effective for training scientific literacy and argumentation skills. This method was able to provide classical mastery results in scientific literacy skills and argumentation skills. N-Gain analysis of scientific literacy skills and argumentation skills shows that there was positive development. The chi square test and Fisher's test show that there was a significant relationship between the two. The results of observations on the implementation of the training showed that the activities had been carried out well. Student responses and activities predominantly support the implementation of training. This research is still less than perfect. There were still students who have not mastery learning. There is also a low level of skill development. For this reason, further research to improve CLC is still very necessary. Remembering literacy and argumentation skills is the basis for developing other thinking skills. It is hoped that the results of this research can be used as an alternative effort to train scientific literacy skills and argumentation skills.
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REFERENCES


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Effectiveness of the Connected Learning Cycle (CLC) for Training Scientific Literacy Skills and Argumentation Skills in Prospective Chemistry Teacher Students


Meldawati. (2017). Building students’ scientific literacy through contextual learning in the physics classroom (Master’s Thesis). University of Tampere
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