

Needs Analysis of Problem-Solving Skills, Social Attitudes, and Cultural Literacy for the Development of a Culturally Responsive Teaching Based Biology E-Module

Nurlia ^{a, b, 1}, Nurhayati B ^{b, 2, *}, Syamsiah ^{b, 3}, Hilda Karim ^{b, 4}

^a Department of Biology Education, Faculty of Teacher Training and Education, Universitas Muhammadiyah Luwuk, Indonesia

^b Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Negeri Makassar, Indonesia

¹ nurlia2811@gmail.com; ² nurhayati.b@unm.ac.id; ³ syamsiah@unm.ac.id; ⁴ hildakarim@unm.ac.id

* Corresponding author: nurhayati.b@unm.ac.id

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ABSTRACT

Despite the growing emphasis on culturally responsive teaching (CRT) in biology education, empirical evidence regarding students' initial profiles of biology problem-solving skills, social attitudes, and cultural literacy remains limited, even though such information is essential for designing contextually relevant learning materials. This study aimed to identify students' biology problem-solving skills, social attitudes, and cultural literacy as an empirical basis for developing a CRT-based e-module. A descriptive research design was employed to objectively describe students' existing conditions without administering any treatment. The study was conducted during the even semester of the 2024/2025 academic year at Universitas Muhammadiyah Luwuk, involving 68 active students from the Biology Education Study Program. Data were collected using questionnaires developed based on the indicators of biology problem-solving skills, social attitudes, and cultural literacy. The collected data were analyzed using descriptive quantitative analysis. The results showed that most students demonstrated moderate biology problem-solving skills (82.36%), good social attitudes (38.23%), and moderate cultural literacy (80.88%). These findings indicate that, although students possess an adequate foundation, there remains considerable room for improvement, particularly in higher-order problem-solving and cultural literacy. Future research should focus on developing and validating CRT-based e-modules based on these identified needs and examining their effectiveness through experimental or quasi-experimental studies across diverse student populations and cultural contexts.

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Keywords: problem solving, social attitudes, cultural literacy, biology learning

Introduction

The skills that students must possess to meet the needs of the 21st century consist of sixteen skills. These skills are divided into three categories, namely basic literacy, competencies, and character qualities. There are six types of basic literacy skills, namely numeracy literacy, science literacy, information technology literacy, financial literacy, and cultural and civic literacy. There are four types of competency skills: critical thinking, creative thinking, communication, and collaboration. There are six types of character quality skills: curiosity, initiative, perseverance, adaptability, leadership, and social and cultural awareness ([WEF, 2015](#)).

Higher education plays an important role in preparing students to become competent and globally competitive individuals. In biology education, students are not only expected to master scientific concepts but also to understand the relationship between biological knowledge, local culture, and community practices. Cultural literacy refers to students' understanding of and ability to interact effectively with people from diverse cultural backgrounds while appreciating local knowledge as a valuable source of scientific learning and biodiversity conservation. According to [Maine et al. \(2019\)](#), cultural literacy is a set of attitudes (inclusion, tolerance, and empathy) and skills (dialogic argumentation) needed to understand others in everyday life. According to [Hui and Cheung \(2015\)](#), indicators of cultural literacy include: multicultural literacy; global awareness; self-direction; higher-order thinking and good reasoning; cooperation and collaboration; interpersonal skills; personal responsibility; and social and civic responsibility.

In the era of globalization, cultural literacy has become increasingly important as cross-cultural collaboration occurs more frequently, both in the world of education and the workplace. [Pujiono and Sahayu \(2021\)](#) state that cultural literacy is one of the keys to success that can help students communicate effectively, especially on campus in the current millennial era. Cultural literacy helps students understand matters related to values and activities on campus. According to [Ochoa et al. \(2018\)](#), cultural literacy teaches students to be culturally aware, training them to interact with things that are different, unfamiliar, or unknown. Students are taught the ability to read and interpret new situations so that they can effectively adapt to new circumstances. This can train students' habits of asking questions with openness, awareness, and reflexivity, which will be applied to themselves and their surroundings.

Social attitudes reflect how students behave and interact with others both inside and outside the learning process. Positive attitudes, such as tolerance, responsibility, and cooperation, are essential for creating a harmonious social environment. Education plays a role in shaping students' social attitudes, especially in multicultural environments. Previous studies have stated that multicultural education is very important. [Bahtiar \(2015\)](#) states that multiethnic education always maintains heterogeneity and plurality in ethnically diverse societies. Students in the Biology Education program at Muhammadiyah University Luwuk come from various ethnic groups, including Banggai, Balantak, Saluan, Gorontalo, Buton, Buol, Bugis, Javanese, Bajo, Tolaki, Toraja, and Taa. This ethnic diversity reflects the multicultural composition of the research sample and provides a relevant context for examining students' cultural literacy. Therefore, given the ethnic diversity of the student population, it is important to examine how students' social attitudes develop through their educational experiences. Understanding students' social attitudes is essential because effective interaction, mutual respect, collaboration, and appreciation of cultural differences are fundamental for creating an inclusive learning environment and for supporting the implementation of CRT. According to [Anindita et al. \(2021\)](#), social attitude is an individual's awareness in determining concrete and repetitive actions toward a social object. [Wiguna \(2017\)](#) argues that social attitude is an attitude possessed by an individual regarding themselves and others, aimed at maintaining good relationships for mutual benefit.

Social attitudes must be possessed by every student because they are very important for learning. Students with good social attitudes are expected to be able to establish good

cooperation to achieve learning objectives. Social attitudes influence learning outcomes ([Parke & Clarke-Stewart, 2011](#); [Ramalingam et al., 2014](#)). According to [Bustami et al. \(2017\)](#), social attitudes are very important in daily life and can be used to interact and socialize within families, communities, and educational institutions. Observations revealed that some biology education students demonstrated inadequate social attitudes, particularly in terms of responsibility, respect for peers from diverse ethnic and cultural backgrounds, and willingness to collaborate with students from different ethnic groups. Considering the multicultural composition of students at Muhammadiyah University of Luwuk, research is needed to design learning materials that encourage inclusive interactions and support the implementation of CRT-based learning. Social attitude indicators include: honesty, discipline, attitude, responsibility, tolerance, cooperation, trust, and democratic pluralism.

Positive social attitudes, such as tolerance for diversity, support students' ability to work together in groups. Problem-solving skills often involve discussion and collaboration. Problem-solving skills are highly needed to address the complex challenges faced in students' daily lives, particularly in the learning process. Problem-solving skills often require discussion, communication, and collaboration with others. Positive social attitudes, such as mutual respect, responsibility, and a willingness to cooperate, contribute to more effective collaborative learning and improve students' problem-solving performance. Therefore, problem-solving skills are essential for addressing complex challenges faced both in learning and in everyday life. According to [Sari et al. \(2021\)](#), students' problem-solving abilities should be the focus of improvement. Lecturers not only function as intermediaries to convey ideas related to the course, but also help students solve problems. A learning process that encourages students to think critically and find solutions to problems can help them acquire problem-solving skills.

Problem solving is an activity that requires sufficient knowledge, skills, and cognitive techniques, as well as systematic methods for solving problems. Problem-solving skills are important for students to learn because they build their way of thinking. Students will interpret problems, gather information, determine solutions, assess possibilities, and propose solutions ([Mahanal et al., 2022](#)). According to [Shahat et al. \(2013\)](#), there are eight indicators of scientific problem-solving ability: identifying and formulating problems; defining and representing problems; formulating expected outcomes; exploring various ways to solve problems; selecting appropriate solutions and implementing them; reviewing data and performing calculations; revisiting ideas; and evaluating the results of solution implementation.

Previous research findings indicate that few studies have comprehensively examined students' cultural literacy, social attitudes, and biological problem-solving skills. Research has mostly focused on cognitive aspects without paying sufficient attention to social and cultural dimensions. Therefore, this study aims to describe the cultural literacy, social attitudes, and biological problem-solving abilities of students in the Biology Education Program at Muhammadiyah University Luwuk. The results of this study are expected to contribute to the design of effective learning resources that are relevant to the needs of students in an ever-changing society.

Methods

This study employed a descriptive quantitative survey design to describe students' biology problem-solving skills, social attitudes, and cultural literacy without administering any treatment or manipulating the research variables. The research was conducted in the even semester of the 2024/2025 academic year at Universitas Muhammadiyah Luwuk. The population of this study consisted of all 68 active students enrolled in the Biology Education Study Program at Universitas Muhammadiyah Luwuk during the 2024/2025 academic year. Because the population was relatively small, all students were included in the study using a total sampling technique.

Data were collected using questionnaires measuring students' biology problem-solving skills, social attitudes, and cultural literacy. The biology problem-solving skills questionnaire was developed based on the indicators proposed by [Shahat et al. \(2013\)](#), the social attitudes questionnaire was adapted from [Bustami et al. \(2017\)](#), and the cultural literacy questionnaire was adapted from [Hui and Cheung \(2015\)](#). Each instrument consisted of 40 statements representing eight indicators of the respective construct. The research questionnaire used a Likert scale with the following criteria: strongly agree (SS); agree (S); disagree (TS); and strongly disagree (STS). The instrument was validated by experts and obtained an average validity score of 4.00, indicating that it was valid. Reliability analysis showed a Cronbach's alpha coefficient >0.70 , indicating good internal consistency. The collected data were analyzed using descriptive statistics, including frequencies, percentages, means, and standard deviations. The results were then classified into predetermined categories and presented using tables and diagrams to provide a clear description of students' biology problem-solving skills, social attitudes, and cultural literacy. The results were categorized according to predetermined criteria and presented in tables and diagrams to describe students' biology problem-solving skills, social attitudes, and cultural literacy. According to [Franestian et al. \(2020\)](#), problem-solving ability is categorized based on scores of 86%-100% (very high); 76%-85% (high); 60%-75% (moderate); 55%-59% (low); $\leq 54\%$ (very low). The categorization of social attitudes according to [Mardapi \(2012\)](#) consists of $X \geq \bar{x} + 1.5Bx$ (very good); $\bar{x} + 1.5Bx > X \geq \bar{x}$ (good); $\bar{x} > X \geq \bar{x} - 1.5Bx$ (fairly good); $X < \bar{x} - 1.5Bx$ (poor). The percentage of cultural literacy among students is categorized according to the criteria set by [Lestari et al. \(2022\)](#), namely scores of 86%-100% (very high); 76%-85% (high); 60%-75% (moderate); 55%-59% (low); $\leq 54\%$ (very low).

Results and Discussion

The research data obtained in this study were collected through responses to a questionnaire on students' biological problem-solving abilities, social attitudes, and cultural literacy. The collected data were then analyzed and presented in the form of descriptive statistics.

1. Descriptive statistics of students' biology problem-solving skills, social attitudes, and cultural literacy

Table 1. Descriptive Statistics of Students' Biology Problem-Solving Skills, Social Attitudes, and Cultural Literacy

Variable	Instrument	Mean	SD	Minimum	Maximum
Biology Problem-Solving Skills	Questionnaire	67.13	7.00	44	79
Social Attitudes	Questionnaire	71.00	5.90	59	86
Cultural Literacy	Questionnaire	69.68	5.96	57	84

Table 1 presents the descriptive statistics of students' biology problem-solving skills, social attitudes, and cultural literacy based on questionnaire data. Among the three variables, social attitudes obtained the highest mean score ($M = 71.00$, $SD = 5.90$), followed by cultural literacy ($M = 69.68$, $SD = 5.96$) and biology problem-solving skills ($M = 67.13$, $SD = 7.00$). These findings indicate that students generally demonstrated positive social attitudes and an adequate level of cultural literacy. However, their biology problem-solving skills were comparatively lower, suggesting that students may still encounter difficulties in applying biological concepts to analyze and solve contextual problems.

2. Results of the analysis of students' biological problem-solving ability

The results of the data analysis in the form of the number and percentage of each category of students' problem-solving ability levels are presented in Figure 1.

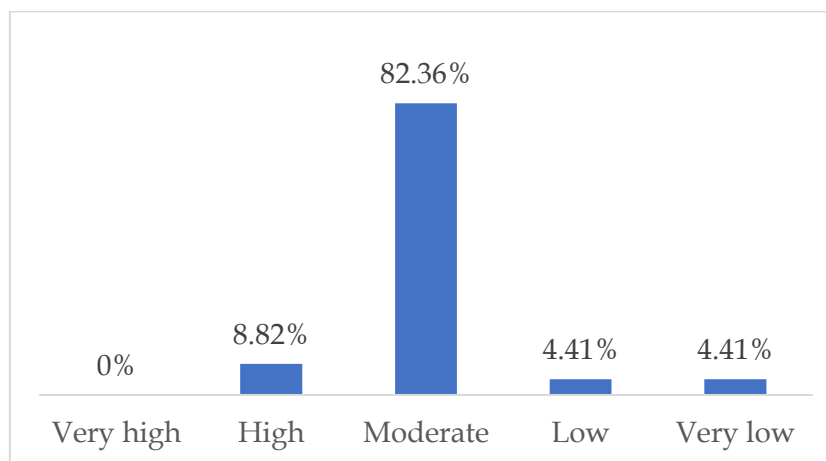


Figure 1. Problem-solving abilities of biology students at Universitas Muhammadiyah Luwuk

The results of the descriptive analysis of the problem-solving abilities of biology students at Universitas Muhammadiyah Luwuk, consisting of 68 respondents, showed that 82.38% were in the moderate category, 8.82% in the high category, and 4.41% each in the low and very low categories. Based on the above, the highest percentage was 82.36% or 56 students who had moderate problem-solving skills in biology. This result indicates that students generally have sufficient problem-solving skills, but these still need to be improved, particularly in terms of critical, creative, and reflective thinking. Strengthening the indicators of exploring alternative solutions, visually representing problems, and conducting in-depth evaluations of the results of solution implementation is important to enhance students' biological problem-solving abilities to the high and very high categories. The results of this study align with [Bahri et al. \(2018\)](#), who found that among the four indicators, the highest achievement was in the "formulating problems" indicator, while the lowest was in the "developing solutions" and "drawing conclusions" indicators.

The findings indicate that most students demonstrated moderate biology problem-solving skills. This result suggests that although students possess a basic ability to solve biological problems, they have not yet consistently applied higher-order thinking skills when analyzing complex or contextual situations. One possible explanation is that biology learning has traditionally emphasized the acquisition of conceptual knowledge rather than providing sufficient opportunities for students to investigate authentic problems, evaluate alternative solutions, and justify their decisions. Students may be able to understand biological concepts but still experience difficulties when applying them to unfamiliar or real-world contexts. Another contributing factor may be the limited integration of local cultural contexts into biology learning. Learning activities that are detached from students' everyday experiences can reduce their ability to connect scientific concepts with real-life situations. As a result, students may find it challenging to analyze biological issues critically and generate appropriate solutions. This finding highlights the need for learning resources that integrate biological concepts with local knowledge and authentic environmental problems, enabling students to construct meaningful understanding while developing their problem-solving skills.

These findings are consistent with the framework proposed by [Dorner and Funke \(2017\)](#), who describe problem-solving as a process involving problem identification, analysis of underlying causes, evaluation of alternative solutions, decision-making, and implementation of appropriate actions. Students who have limited opportunities to practice these processes are less likely to develop advanced problem-solving competencies. Similarly, [Bariyyah \(2021\)](#) emphasized that problem-solving skills are essential for preparing students to face the complex challenges of the twenty-first century because they promote critical, creative, and reflective thinking. Therefore, the moderate level of problem-solving skills observed in

this study reinforces the need to develop instructional materials that provide authentic, contextual, and culturally relevant learning experiences, such as a CRT-based biology e-module.

The moderate level of biology problem-solving skills observed in this study indicates that students require more learning experiences that explicitly engage them in analyzing and solving authentic biological problems. Given that students also demonstrated moderate cultural literacy, learning activities should connect biological concepts with local cultural knowledge and environmental issues that are familiar to students. Therefore, the findings support the development of a CRT-based biology e-module that incorporates contextual case studies, ethnobiological examples, and inquiry-based problem-solving tasks. Such learning activities are expected to help students relate scientific concepts to real-life situations, evaluate alternative solutions, and make evidence-based decisions, thereby strengthening their biology problem-solving skills while simultaneously enhancing cultural literacy.

3. Results of analysis of student social attitude

The results of the data analysis in the form of the number and percentage of each category of social attitude possessed by students are presented in Figure 2.



Figure 2. Social Attitudes of Biology Education Students
Universitas Muhammadiyah Luwuk

The results of the descriptive analysis of the social attitudes of biology education students at Universitas Muhammadiyah Luwuk, consisting of 68 respondents, showed that 38.23% were in the good category, 32.35% in the fairly good category, and 14.71% each in the very good and poor categories. Based on the above, the highest percentage was 38.23% or 26 students, who had good social attitudes. The findings indicate that although students' social attitudes were generally in the good category, this condition was not yet optimal, as only 38.23% of students reached the good category. In comparison, 47.06% remained in the fairly good and poor categories. Therefore, social attitude remains an important variable to be strengthened through the development of the CRT-based biology e-module. The purpose is not merely to overcome low social attitudes but also to reinforce existing positive behaviors and encourage their consistent application through culturally contextualized and collaborative learning experiences. This is particularly relevant because cultural diversity among students does not automatically lead to positive social interactions without learning activities that facilitate mutual understanding, cooperation, respect, and reflection on shared social values. According to [Setiawan and Suardiman \(2018\)](#), adequate social attitudes show several emerging elements, such as honesty during learning and social interactions, discipline in daily life, responsibility for tasks and obligations, politeness toward lecturers and peers, and confidence in class.

The social attitudes of students categorized as good can indicate that the learning program or campus environment has had a positive influence, but a more systematic approach may be needed to optimize the development of social attitudes, such as through community service activities, group work, or discussions involving social values. According to [Septiani et al. \(2020\)](#), the development of social attitudes through learning activities is a crucial concern. As stated in the Indonesian education curriculum, social attitudes are one of the core competencies that must be developed in the learning process. Social attitudes include honesty, discipline, politeness, confidence, caring, and responsibility. These attitudes can be developed in educational institutions and will later become good habits in society.

Students must have excellent social attitudes because these attitudes are important in determining their academic and social success. Good social attitudes enable students to work in teams, respect differences of opinion, and build mutually supportive relationships with friends, lecturers, and the community. Students with excellent social attitudes are more adaptable in diverse environments, making them better prepared to face challenges in the workplace, especially in the current 4.0 era. Good social attitudes also shape individuals who care about others, create an inclusive environment, and strengthen relationships with friends, which undoubtedly has a positive impact on both themselves and society. According to [Perrault et al. \(2011\)](#), in the 4.0 industrial era, an individual's social attitudes impact their survival. This era demands the ability to learn to live together, thus requiring good social attitudes.

4. Results of cultural literacy analysis

The results of the data analysis in the form of the number and percentage of each category of student cultural literacy skills are presented in Figure 3.

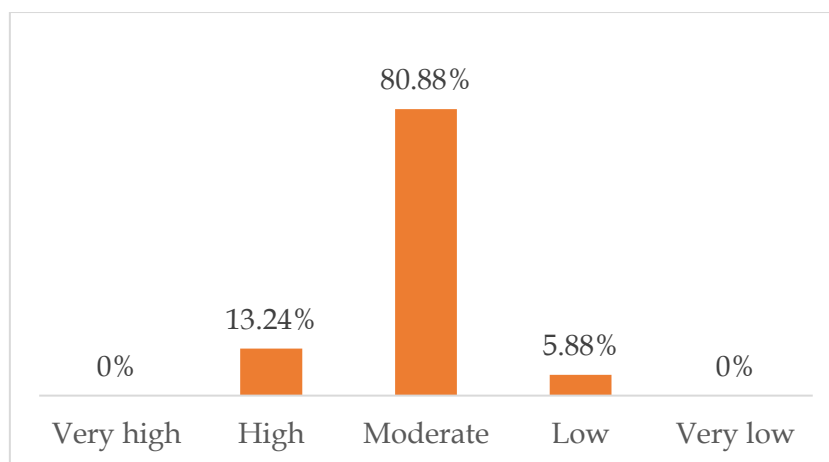


Figure 3. Cultural literacy of biology education students
Universitas Muhammadiyah Luwuk

The results of the descriptive analysis of cultural literacy data of biology education students at Universitas Muhammadiyah Luwuk, consisting of 68 respondents, show that 80.88% are in the moderate category, 13.24% in the high category, and 5.88% in the low category. Based on this description, the highest number is 80.88% or 55 students who have moderate cultural literacy skills. The general level of cultural literacy falling within the moderate category indicates that biology education students at Universitas Muhammadiyah Luwuk have a basic understanding of culture; however, the application of these values in daily life and within the learning process remains limited.

The finding that most students demonstrated moderate cultural literacy indicates that they have begun to appreciate cultural diversity but have not yet consistently integrated cultural knowledge into their learning and interactions. This may be because biology learning has largely emphasized scientific concepts while providing limited opportunities for students

to explore the relationship between biological knowledge and local cultural practices. As a result, students possess a basic understanding of cultural diversity but have not fully developed the ability to apply cultural perspectives when analyzing biological issues. These findings underscore the need for learning resources that intentionally integrate local cultural knowledge into biology instruction, such as a CRT-based biology e-module, to strengthen students' cultural literacy through meaningful and contextually relevant learning experiences. [Hesti et al. \(2024\)](#) state that cultural literacy is the ability to understand, analyze, and apply culture in daily life. This ability is crucial for fostering a sense of love for the cultures present in the region and across the archipelago.

In efforts to produce graduates who can live and work in transcultural and transdisciplinary environments, cultural literacy is vital in higher education. Currently, students must be directly involved in interactions and collaborations with diverse cultures ([Helaluddin, 2018](#)). Furthermore, according to [Ochoa et al. \(2016\)](#), higher education institutions must produce graduates who are adaptable and flexible so they can work in transdisciplinary and transcultural environments. Some terms used in the review are 1) global competency; 2) cosmopolitanism; 3) global citizen; and (4) cosmopolitan capital. In today's era of globalization, cultural diversity is inevitable. Cultural literacy is essential for living and working in a global society in the era of the 4th Industrial Revolution. Given that most students in this study demonstrated only moderate cultural literacy, the findings indicate that existing learning practices have not fully supported the development of students' ability to understand and apply cultural knowledge in biology learning. Therefore, integrating cultural literacy into classroom instruction is recommended as a targeted response to these findings. In particular, incorporating local cultural knowledge and ethnobiological examples into biology learning through a CRT-based e-module can provide students with meaningful opportunities to connect scientific concepts with their cultural experiences, thereby strengthening their cultural literacy.

The findings indicate that students generally possess adequate biology problem-solving skills, good social attitudes, and moderate cultural literacy. Although the descriptive analysis showed that students had adequate biology problem-solving skills and good social attitudes, these variables were still included in the development of the e-module because the purpose of the product was not limited to improving the lowest-performing variable. The development of the CRT-based e-module was designed to provide an integrated learning experience that strengthens several competencies simultaneously. Biology problem-solving skills remain important because students need to apply biological concepts to authentic problems related to local plants, their classification, utilization, and conservation. Similarly, social attitudes remain relevant because learning activities involving discussion, collaboration, respect for different cultural perspectives, responsibility, and cooperation require students to consistently practice positive social behaviors.

Although students at Universitas Muhammadiyah Luwuk come from diverse ethnic backgrounds, cultural literacy remained at a moderate level. This suggests that a multicultural learning environment alone is not sufficient to develop high cultural literacy. Students need learning experiences that explicitly connect biological concepts with local cultural knowledge and encourage appreciation of diverse cultural perspectives. Therefore, integrating local cultural contexts into a CRT-based biology e-module is expected to strengthen students' cultural literacy further. The research results show that, in general, students have moderate problem-solving skills in biology, good social attitudes, and moderate cultural literacy. These findings serve as an important foundation for the development of e-modules based on Culturally Responsive Teaching (CRT), indicating the need for innovative learning that not only emphasizes mastery of biology material but also connects it to the local cultural context to enhance cultural literacy and problem-solving skills. Additionally, the generally good social attitudes can be leveraged to promote collaborative learning based on CRT, so that the developed e-modules are expected to equip students with more comprehensive and relevant 21st-century competencies.

Conclusion

Based on the findings, students' biology problem-solving skills were predominantly in the moderate category (82.36%), social attitudes were generally in the good category (38.23%), and cultural literacy was predominantly in the moderate category (80.88%). These results indicate that students have an adequate foundation in problem-solving, social interaction, and cultural literacy; however, further improvement is needed, particularly in strengthening problem-solving skills and enhancing the application of cultural knowledge in biology learning. Therefore, the product is not designed solely to remediate low achievement, but to enhance existing competencies and promote their more consistent application in authentic learning situations. These findings provide an empirical basis for developing a Culturally Responsive Teaching (CRT)-based biology e-module that better supports students' academic and cultural competencies.

Generative AI Disclosure

The use of artificial intelligence in this manuscript is limited to translation and sentence refinement.

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