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Science Literacy Profile and Students' Cultural Character are taught using Science E-Modules based on Ethnoscience oriented towards Green Chemistry

Nurul Fauziah[1*], Muhammad Shohibul Ihsan[2]

[1] Department of Elementary School Teacher Study Program, STKIP Taman Siswa Bima, Bima – Indonesia.
[2] Department of Biology Education, Nahdlatul Wathan University, Mataram, Indonesia.

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Corresponding Author:
Nurul Fauziah
nurulfauziah@tsb.ac.id

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Abstract: Science learning in secondary schools has not been fully linked to local culture and the environment, and has not supported students' scientific literacy and cultural character. This is because teachers have difficulty learning the relationship between local culture and finding the right green chemistry principles with science learning. To strengthen the concept of science learned, ethnoscience learning can be oriented with the principles of green chemistry contained in learning media in the form of e-modules. This study aims to determine the profile of scientific literacy and cultural character of students who have been taught with the developed e-modules. The results of the study showed that students' scientific literacy competencies in interpreting scientific data and evidence, designing and evaluating scientific investigations, and explaining scientific phenomena were respectively 57.67, 87.12 and 66.67. This shows that students' literacy abilities are in the moderate category. The highest literacy level achievement is at level 1, at 76.67%, and the lowest at level 6 at 5.0%. While the highest cultural character value is in the curiosity indicator at 85% and the lowest is friendly/communicative with an achievement of 75%.

Keywords: Cultural Character; E-Modules; Science Literacy; Science Learning

Introduction

The rapid development of science and technology has greatly influenced human life. This is the main reason why education is needed that can produce students who are able to develop and compete in the advancement of science and technology and have concern for the environment. The results of the 2022 PISA (Program for International Student Assessment) study showed that Indonesia was ranked 71st out of 81 countries that participated in the PISA test with a science literacy score of 382, or a decrease of 13 points, and the average international score decreased by 12 points (OECD, 2023). On the other hand, it cannot be denied that the rapid development of globalization and science and technology has also had an impact on the erosion of local cultural values and environmental conservation in Indonesia. (Fauziah & Ningsyih, 2022). The Bima and Lombok areas of West Nusa Tenggara are blessed with a wealth of culture and local wisdom that is very diverse and fascinating. However, the rapid flow of globalization has resulted in the erosion of local cultural values in the Bima, Lombok and surrounding areas.

One of the efforts to answer the challenges in the world of education is that a change in focus and paradigm is needed in seeing and supporting the potential of students. This paradigm change is needed so that students can understand concepts, principles, procedures, and facts that are useful in solving problems and can increase conservative values towards the environment (Earth & Paradise, 2019) .The paradigm shift is also conducive to improving students' scientific literacy and cultural character. In addition, it can be done by optimizing contextual integrated learning that strengthens local, environmental and technological potential, so that it becomes a form of integrated relationship as a source of learning (Sudarmin, 2014). Local potential can provide valuable contributions in

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identifying and understanding traditional knowledge about natural concepts, which in turn can be the basis for the development of more sustainable environmental principles that can be applied in learning. Ethnoscience-based learning is meaningful learning that allows students to learn while connecting the learning materials learned with the context of everyday life and are able to apply science wisely to maintain the sustainability of culture and customs (Puspasari, et al. 2019; Atmojo, 2012; Damayanti, et al. 2012).

In addition, to strengthen the concept of science learned, ethnoscience learning can be oriented with the principles of green chemistry. Green chemistry is an alternative approach to addressing environmental problems which is defined as eliminating the use and production of chemicals that are harmful to the environment and human health by referring to 12 principles.(Karpudewan & Kulandaisamy. 2018; Karpudewan & Meng. 2017; Anastas & Eghbali. 2010).Ethnoscience learning that is oriented towards green chemistry will bring students directly involved with the environment and the real world, which makes students able to identify problems in the environment, more easily apply the materials learned to understand and provide solutions to problems that occur in the environment, have conservation values towards the environment, have a tendency to participate in activities to solve environmental problems, and use scientific knowledge and use environmentally friendly chemical products and processes.(Jumirah, et al. 2021;Susanti, 2022; Auliah 2018). Direct involvement of students with the environment will also improve students' scientific literacy and cultural character.

Science learning in secondary schools has not been fully linked to local culture and the environment, and has not supported students' scientific literacy and cultural character. This is because teachers have difficulty learning the relationship between local culture and finding the right green chemistry principles with science learning. In the science learning process involving practicums, this is rarely done due to limited tools and materials. The practicums carried out are guided by existing tools and materials, although in fact with the same goal teachers can replace the tools and materials with those that are easier to obtain, safer and more economical. Students also admit that they are still afraid to do practicums in the laboratory because there are many hazardous materials. However, on the other hand, students have a high curiosity about the science concepts taught regarding their application in everyday life, but to obtain this has not been fully facilitated in learning. In addition, teachers have difficulty creating teaching materials to facilitate students' scientific literacy and cultural character.

Ethnoscience, as a learning approach, integrates students' local and cultural knowledge with science. By linking learning material to the local cultural context, students can more easily understand and internalize science concepts. On the other hand, green chemistry provides an important perspective in science education, especially in the context of sustainability. Green chemistry principles emphasize the use of environmentally friendly materials, reducing waste, and creating more efficient processes (Zidni & Eilks, 2022). It is hoped that the use of the green chemistry-oriented Etnoscience-based Science E-Module can increase students' scientific literacy and build cultural character that respects the environment. E-Modules enable students to learn independently and interactively, provide easier access to information, and give them the tools to explore science concepts in a more interesting and relevant way ((Zidni & Eilks, 2020).

With this background, this research aims to analyze the scientific literacy profile and cultural character of students who are taught using the Green Chemistry-oriented Etnoscience-based Science E-Module. It is hoped that this research can provide new insights in developing learning methods that are more effective and relevant in the modern era.

Therefore, it is necessary to know the profile of scientific literacy and cultural character of students who are taught through teaching media in the form of ethnoscience-based science e-modules oriented towards green chemistry. Ethnoscience-based science e-modules oriented towards green chemistry are believed to be able to create contextual and meaningful learning as well as scientific, environmental and technological literacy.

Method

The subjects of the study were 30 students of SMPN 8 Kota Bima. Data collection using the Scientific Literacy Competency Question Instrument adapted from the Scientific Literacy Measurement Instrument in PISA 2018 which emphasizes interest and attraction to science and technology, evaluates scientific approaches to investigation, and awareness of issues and phenomena that occur in the environment and a questionnaire on cultural character attitudes. The test consists of 25 multiple-choice questions representing each level of student scientific literacy expertise to measure the scientific literacy domain (context, competence, knowledge and attitude). The following are the levels of scientific literacy (1) Understanding natural science, norms and methods of science and scientific knowledge; (2) Understanding key scientific concepts; (3) Understanding how science and technology work together (4) Appreciating and understanding the influence of science and technology in society; (5) The relationship between competencies in the context of science, the ability to read, write and understand human knowledge systems; (6) Applying some scientific knowledge and the ability to consider in everyday life. As well as indicators of cultural character. The cultural characteristics taken in this study are curiosity, environmental concern, social concern, friendship/communication, appreciation of achievement, and love of the homeland (Suyitno, 2012; Daniah, 2016).Qualitative descriptive data analysis techniques, with the following stages.

1. Scoring the students' answers according to the PISA score that has been obtained from Take The Test: Sample Questions from OECD's PISA Assessment. Correct answers are given a score of 2 and incorrect answers are given a score of 0. Specifically for descriptive questions, if the answer is incomplete or partial, it gets a score of 1.
2. Calculating the percentage of student achievement in scientific literacy.
3. After being presented as a percentage, the data is described in general based on the level of questions and science process competencies with the categories in Table 1.

Table 1. Scientific literacy competency categories

Interval	Category
86-100	Very high
76-85	Tall
60-75	Currently
55-59	Low
<54	Very low

4. The data on cultural character attitudes were calculated using percentages.

Result and Discussion

Based on the scientific literacy competency, it shows that the percentage of each competency can be seen that the dominant competency from the scientific literacy competency is the competency of designing and evaluating scientific investigations with a percentage of 87.12% with details can be seen in Table 2.

Table 2. Recapitulation Data of Students' Science Literacy Competencies

Scientific literacy competency	Acquisition
Interpreting scientific data and evidence	57.67
Designing, evaluating scientific investigations	87.12
Explaining phenomena scientifically	66.67

The competence of designing and evaluating scientific investigations is a scientific literacy competence where students are directed to explain and consider inquiry activities and propose ways to answer and handle scientific questions. Learning activities that facilitate this are in the activity of designing simple practical activities related to additives. In this activity, simple practicals carried out by students are making ice cream using natural stabilizers from seaweed and making MSG from tomatoes. The activities carried out include designing practical work steps, identifying important concepts resulting from the practical work which are then poured into a table of observation results, explaining and evaluating various methods used in answering problem formulations and proving hypotheses that have been given in the previous learning syntax. This learning activity refers to several components contained in the competence of designing and evaluating scientific investigations that are guided by PISA (2018) including (1) evaluating ways to explore questions given scientifically (2) explaining and evaluating various methods used by scientists to ensure data reliability and objectivity of an investigation (3) Distinguishing possible questions to investigate scientifically. (OECD, 2018). The practical activity also refers to the principle of green chemistry, namely designing a safe chemical process; and using renewable raw materials. The concept of ethnoscience applied is shown by the use of raw materials that are familiar in the Bima and Lombok areas, where seaweed is an iconic raw material originating from Bima and Lombok and the use of tomatoes that are currently widely traded.

The survey results showed positive results, which are different from the opinion that Indonesian students are not only dominated by conceptual abilities but also inquiry-based abilities can show good results. Permanasari, et al., (2016) revealed that science learning in Indonesia generally emphasizes memorization without being followed by an understanding that students can apply to real life. To achieve high scientific literacy, learning needs to use appropriate models, methods, strategies and approaches and be carried out continuously. The competence to interpret data and scientific evidence is the competence that obtains the lowest percentage. Competence that directs students to analyze and evaluate scientific information, claims and arguments in various representations. This learning activity refers to several components contained in the design and evaluation competencies that are guided by PISA 2018, including (1) identifying assumptions, evidence and reasoning in related sciences (2) transforming data from one representation to another (3) distinguishing between arguments based on scientific evidence and theory and those based on other considerations (4) evaluating scientific arguments and evidence from different sources (eg, newspapers, internet, journals) (OECD, 2018). Previous research shows that students have difficulty using scientific evidence and making decisions on socio-science issues (OECD, 2006) and this is predicted to be related to students' weak scientific literacy skills. Through real and relevant situations, scientific literacy can be developed (Dam & Volman, 2004; Dewi et al 2019). Real situations will encourage students to be interested in learning science because they know the importance of science in everyday life (Atmojo et al 2019; Fathonah & Subali, 2020).

Scientific literacy competencies consist of 6 levels, namely: (1) Understanding natural science, norms and methods of science and scientific knowledge; (2) Understanding key scientific concepts; (3) Understanding how science and technology work together (4) Appreciating and understanding the influence of science and technology in society; (5) The relationship between competencies in the context of science, the ability to read, write and understand human knowledge systems; (6) Applying some scientific knowledge and the ability to consider in everyday life (Rusdi, et al., 2017). The results of students' scientific literacy can be seen in Figure 1.

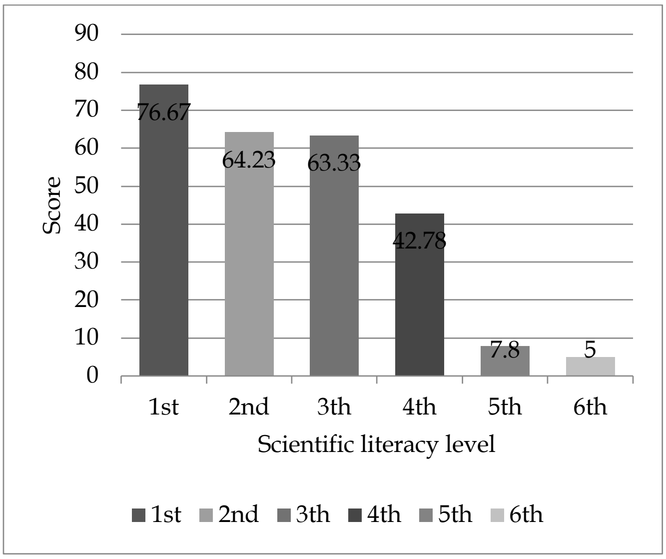

Figure 1. Scientific Literacy Level Score

Based on Figure 1, literacy questions are divided into 6 levels. The highest literacy level achievement is at level 1, at 76;67, and the lowest at level 6 at 5.0. This shows that students' abilities based on the question level are still very low. Based on the results of measuring the level of scientific literacy competency above, further research will be carried out related to the effectiveness test of the developed product. This is in accordance with the opinion of Ansyari (2015) who stated that the application of learning that is in accordance with the characteristics of students and the characteristics of the material taught can improve the profile of students' scientific literacy (Alim & Subali, 2019).

In addition, measurements were also carried out related to the cultural character values of students. The measurement results can be seen in Table 4.

Table 3. Student cultural character profile

Cultural character indicators	Percentage of earnings
Curiosity,	85
Environmental care,	82
Social care,	79
Be friendly/communicative,	75
Appreciating achievements,	78
Love culture	80

Based on the percentage of students' cultural character profiles, it shows that the curiosity indicator gets the highest score followed by environmental care and love of culture. This is the result of the learning process that begins with an introduction to the values being developed, then the teacher guides students to be active. This causes students to actively formulate questions, seek sources of information, and collect information from sources, process information that is already owned, reconstruct data, facts, or values, present the results of the reconstruction or value development process, foster cultural values and character in themselves through various learning activities that occur in class, school, and assignments outside of school. This is in accordance with the opinion Ismawati, et al (2020) that states that consider local wisdom, encouraging them to think critically about how science and culture interact with each other.

When students learn about science through the lens of their culture, their interest and motivation to learn can increase (Mamluaturrahmatika, et al, 2024; Liang, et al, 2023; Dewi et al, 2021) Contextual learning makes material more interesting and easy to understand (Abonyi, et al, 2014; Nurcahyani, et al, 2021; Ningrat et, al. 2024). Ethnoscience values local knowledge, so students feel valued and connected to their culture. This strengthens their identity and builds a sense of pride in their cultural heritage (Efendi & Muliadi, 2023; Suastra & Pujani, 2021).

Conclusion

The results of the study showed that students' scientific literacy competencies in interpreting scientific data and evidence, designing and evaluating scientific investigations, and explaining scientific phenomena were 57.67, 87.12 and 66.67, respectively. This indicates that students' literacy skills are in the moderate category. The highest literacy level achievement was at level 1, at 76.67%, and the lowest at level 6 at 5.0%. Meanwhile, the highest cultural character value was in the curiosity indicator at 85% and the lowest was being friendly/communicating with an achievement of 75%.

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Author Contributions

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Conflicts of Interest

The authors declare no conflict of interest.

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