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Student STEM Literacy Ability Profile on Environmental Change Issues

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Abstract: *In addressing environmental issues, it is important to measure STEM literacy achievement to increase students' environmental awareness and equip them with the necessary skills to contribute to finding solutions. This research aims to determine the profile of students' STEM literacy achievement in Bandung regarding environmental change issues. The research method used is descriptive with a qualitative approach. The research subjects comprised 193 tenth-grade students selected from SMA Negeri 1 Bandung, SMA Negeri 4 Bandung, and SMA Negeri 9 Bandung for the 2023/2024 academic year, chosen through simple random sampling. The research instrument consisted of 40 multiple-choice questions on environmental change issues, covering seven STEM literacy indicators: explaining phenomena scientifically, evaluating and designing scientific investigations, interpreting data and evidence scientifically, understanding technological principles, developing solutions to achieve goals, formulating situations mathematically, and using concepts, facts, procedures, or reasoning. Data analysis was conducted by calculating the average score of students' STEM literacy achievement per indicator as a percentage. The research results indicate that the percentage of students' STEM literacy achievement is 70%, categorized as moderate. The percentages per STEM literacy indicator are as follows: explaining phenomena scientifically at 71%, evaluating and designing scientific investigations at 61%, interpreting data and evidence scientifically at 73%, understanding technological principles at 76%, developing solutions to achieve goals at 74%, formulating situations mathematically at 61%, and using concepts, facts, procedures, or reasoning at 61%.*

Keywords: *STEM Literacy, Environmental Change, High School Student, Descriptive.*

1. INTRODUCTION

Global markets and modern needs, such as sustainable energy, efficient health care, and the development of appropriate technologies, require a strong education in science, technology, engineering, and mathematics (STEM). STEM literacy, which includes a basic understanding of the core concepts in these fields, is essential not only for preparing future STEM professionals but also as an essential skill for everyone to face an increasingly information—and technology-based world (Kelp *et al*., 2023; Simbolon *et al*., 2019) So STEM literacy becomes very important, one of which is in the field of biology teaching (Stains *et al*., 2018).

In the 21st century, the world has become increasingly connected and dependent on scientific knowledge. Along with the development of education in the world, including in Indonesia, the importance of STEM education in schools is emphasized (Miranti *et al*., 2020). STEM refers to the integrated teaching and learning of Natural Sciences, Technology, Engineering, and Mathematics. One of the abilities students need in STEM education is literacy, especially STEM literacy (Widya *et al*., 2019). STEM literacy can be applied to various scientific disciplines, including in the context of biological sciences. In biology subjects, various research areas can increase students' STEM literacy (Banila *et al*., 2021) to overcome the low

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level of student intention to know and study environmental problems (Nasution, 2016). STEM literacy includes understanding and applying scientific concepts, thinking critically, solving problems, and making informed decisions related to Natural Sciences, Technology, Engineering, and Mathematics issues. STEM literacy is not limited to theoretical knowledge but also includes practical skills such as scientific communication, technological literacy, and the ability to analyze and evaluate evidence to make informed decisions and participate in societal issues (Tang & Williams, 2019).

The world faces an environmental crisis, with many related challenges threatening our natural balance. This crisis has a broad impact on humanity and could endanger survival (Dianjaya & Epira, 2020). Environmental conflicts arise over various ecosystem services and natural resource management issues at the global level. These problems include loss of biodiversity, poor air quality, forestry, water shortages, and land degradation. Some action is needed to address this problem as the situation continues to worsen worldwide (Arora *et al*., 2018; Bob & Bronkhorst, 2011).

There has been growing concern about environmental change and sustainability issues in recent years. Issues such as climate change, pollution, and resource depletion require a strong foundation in STEM literacy to understand complex scientific concepts and make informed decisions about how to address these challenges (Miranti *et al*., 2020). Understanding environmental changes based on sustainable development issues is very important for students. By gaining knowledge about these topics, students can become responsible and contribute to environmental Stewardson achieving sustainable development goals (López Chao *et al*., 2020). In general, learning that begins with providing students with stimuli about everyday life can improve their engineering abilities and help them understand problems in their environment (Nurbayani *et al*., 2023). This understanding will not only help students make the right decisions in their daily lives but also allow them to actively participate in initiatives aimed at mitigating climate change and preserving natural resources for future generations (Wahyuni, 2019).

The focus in STEM is on how to develop students' engineering abilities. The development of students' engineering abilities in research is better after STEM learning is carried out than those who do not use STEM. This shows that STEM-based learning has a more positive impact on engineering abilities. The engineering process consists of the stages of thinking, designing, creating, and testing, systematically trains students to understand problems well, generate various ideas, determine solutions, and express these ideas in more focused and planned designs (Nurbayani et al., 2023; Rukoyah, 2020).

With the increasing demand for skilled professionals in STEM fields, educational systems must prioritize assessing and developing these competencies. Measuring STEM literacy allows educators to identify areas where students may be experiencing difficulties so they can adjust teaching methods and provide appropriate support to address these deficiencies (Sari et al., 2021).

Assessment of students' STEM literacy achievement is very important. This is done to measure the success and accuracy of what has been designed by the teacher. Apart from that, this assessment can also help see the influence of STEM literacy on students' level of understanding. STEM literacy helps students design problems, reason based on hypotheses, and combine information in learning (Ningrum & Rahmi, 2021). Thibaut (2018) It also states that STEM literacy, which involves understanding the concepts of science, technology, engineering, and mathematics, is very important in an increasingly complex and technology-based world. Therefore, this research aims to determine the profile of students' STEM literacy abilities in the context of environmental changes and sustainability issues to determine the extent of students' STEM literacy abilities.

2. RESEARCH METHODS

This type of descriptive research uses a qualitative approach that aims to describe phenomena, facts, events, or occurrences that are current or have occurred. With this approach, the focus is on actual problems occurring or have occurred without any manipulation. According to Frankel *et al* (2012), The descriptive method is research that describes and interprets objects as they are and does not involve treatment,

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manipulation, or changes to the sample being investigated, so there is no need to organize a control or experimental group. In descriptive research, researchers try to describe events, situations, or phenomena that are the focus of the research as accurately as possible without systematic manipulation (Sukardi, 2008). This research was conducted to evaluate students' STEM literacy achievements in biology learning material on environmental change issues for class X MIPA students in Bandung. Implementation will occur in May 2024 for the 2023/2024 academic year.

The researcher took the population in this study from several public high schools in Bandung, namely SMA Negeri 1 Bandung, SMA Negeri 4 Bandung, and SMA Negeri 9 Bandung, while the samples taken were 6 classes X MIPA, totaling 193 students with a simple sampling technique. Random sampling. Data collection techniques through student STEM literacy instruments. The research instrument is in the form of STEM literacy questions that adapt to the material context of environmental change issues. The instruments in this research include 40 multiple choice test questions based on indicators from PISA 2015 and NAEP 2014 in the form of indicators for explaining phenomena scientifically with 2 questions, evaluating and designing scientific investigations with 5 questions, interpreting data and evidence scientifically with five questions, understanding principles - technological principles with 11 questions, developing solutions to achieve goals with 8 questions, formulating situations mathematically with 5 questions, and using concepts, facts, procedures or reasoning with 4 questions. The question instrument created in this research has gone through the validation analysis test stages of the question items by 3 validators/experts and was processed using Anates 4.0.

Based on the results, 36 valid questions were produced, with a medium level of difficulty, good discriminating power, and a very high-reliability value of 0.90. The data analysis technique used in this research is descriptive categorization. The stages in categorizing are grouping data, tabulating data, presenting researched data, and carrying out calculations to answer the problem formulation in this research. Data processing in this research was carried out using a percentage formula. The assessment criteria for each data are presented below.

Table 1. STEM Literacy Ability Assessment Criteria

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

(Chairulli & Rahmi, 2022).

3. RESULTS AND DISCUSSION

Based on the research results and data analysis obtained regarding students' STEM literacy abilities in biology learning for the class. The following are the percentages of data analysis results from Anates 4.0:

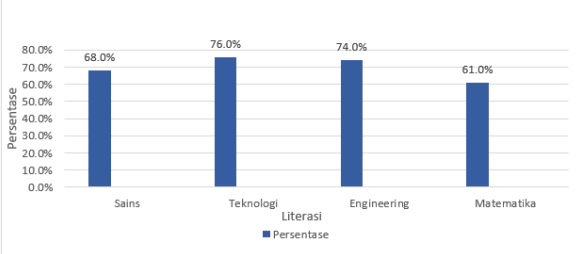

Figure 1. Results of STEM Literacy Analysis

Based on Figure 1, the percentage of student achievement in scientific literacy is 68% in the medium category, in technological literacy it is 76% in the medium category, then in technical literacy it is 74% in the medium category, and in mathematics literacy it is 61% in the medium category. Currently. If you average these four literacies, the STEM literacy ability of high school students in Bandung is 70%, including in the medium category.

The data obtained in Figure 1 was then strengthened by analysis of each indicator for literacy, especially the science and mathematics indicators. This can clarify students' abilities in STEM literacy, as shown in Figure 2 of the results of the analysis of science indicators.

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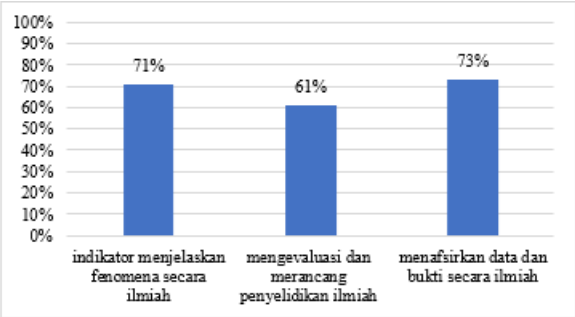

Figure 2. Analysis Results on Scientific Literacy Indicators

Based on Figure 2, there are 3 sub-indicators of the scientific literacy indicators shown in this research. The results of students' scientific literacy achievements in the sub-indicator of explaining phenomena scientifically are 71%, which is in the medium category, then in the sub-indicator evaluating and designing scientific investigations, it is 61%, which is in the medium category, then in the sub-indicator interpreting data and evidence scientifically 73% is in the medium category. Then, proceed with analyzing the mathematical literacy indicators seen in Figure 3.

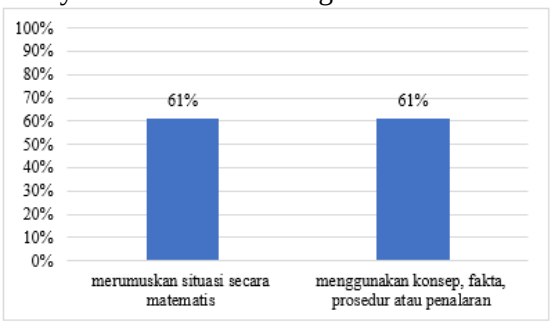

Figure 3. Analysis Results on Mathematical Literacy Indicators

Figure 3 shows 2 sub-indicators of the mathematical literacy indicators shown in this research. The results of mathematical literacy achievement on the indicator of formulating situations mathematically are 61%, which is in the medium category, and on the indicator of using concepts, facts, procedures, or reasoning, it is 61% in the medium category.

Based on the research data above, students' STEM literacy abilities are in the medium category. This can be seen from the results of the STEM literacy analysis in Figure 1, where the perliteracy value shows that it is in the medium category. These results indicate that STEM literacy achievement among students has still not reached the optimal level and needs further improvement. According to Dewi et al. (2021) The results showing this moderate percentage can be caused by a lack of resources and funding or by qualified teachers who can teach subjects less effectively. It can also be because some individuals may be less interested or motivated to engage with subjects because subjects that use a STEM approach or model can be challenging and require a high level of critical thinking and problem-solving skills. Then Joseph (2019) Explains that STEM literacy achievement refers to an individual's proficiency and understanding of science, technology, engineering, and mathematics.

Other research also states that students in STEM literacy-based biology learning are still less enthusiastic about reading (Chairulli & Rahmi, 2022). They are more interested in learning related to technology. In addition, teachers do not yet know how to assess students' STEM literacy achievements in biology learning (Ningrum & Rahmi, 2021). In Utami's research (2023) The low achievement of students' abilities is due to teachers not being optimal in creating questions that can provide a stimulus for achieving these abilities, and the questions only focus on understanding the material. In line with Sukarno, *et al* (2013) Learning at school only emphasizes mastery of concepts.

In line with that, the explanation above is strengthened by the results of the analysis of each indicator in Figure 2 for the analysis of science indicators and Figure 3 for the analysis of mathematics indicators. The results obtained by students for each indicator are in the medium category, but the smallest percentage is in the indicators of evaluating and designing scientific investigations (scientific literacy), formulating situations mathematically, and using concepts, facts, procedures or reasoning (mathematical literacy) which is equal to 61%. This shows that there is still a lack of students' ability in STEM literacy, especially in science and mathematics indicators.

Analysis of the research results found that the main cause of the lack of improving students' STEM literacy was the less-than-optimal use of strategies and facilities in learning to increase students' STEM literacy. Based on this, teachers

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are expected to be able to innovate to increase students' STEM literacy through several methods, namely the use of STEM-based learning processes (Ningrum & Rahmi, 2021) and the existence of learning facilities that increase students' STEM literacy (Chairulli & Rahmi, 2022), one of which is by increasing the development of creating questions that can provide a stimulus for students to increase STEM literacy.

4. CONCLUSION

Based on the research results and discussions presented, it can be concluded that students' STEM literacy achievements in biology learning on environmental change issues are divided into 4 aspects: scientific literacy, technological literacy, engineering literacy, and mathematical literacy, which are in the medium category.

5. REFERENCES

Arora, N. K., Fatima, T., Mishra, I., Verma, M., Mishra, J., & Mishra, V. (2018). Environmental sustainability: Challenges and viable solutions. *Environmental Sustainability*, *1*(4), 309–340. https://doi.org/10.1007/s42398-018-00038-w

Banila, L., Lestari, H., & Siskandar, R. (2021). Penerapan blended learning dengan pendekatan STEM untuk meningkatkan kemampuan literasi sains siswa pada pembelajaran biologi di masa pandemi covid-19. *Journal of Biology Learning*, *3*(1), 25. https://doi.org/10.32585/jbl.v3i1.1348

Bob, U., & Bronkhorst, S. (2011). Environmental conflicts: Key issues and management implications. *African Journal on Conflict Resolution*, *10*(2). https://doi.org/10.4314/ajcr.v10i2.63307

Chairulli, M., & Rahmi, Y. L. (2022). Capaian Literasi STEM Peserta Didik dalam Pembelajaran Biologi Kelas XI di SMA. *Journal for Lesson and Learning Studies*, *5*(1), 143–148. https://doi.org/10.23887/jlls.v5i1.47005

Dewi, C. A., Erna, M., Martini, M., Haris, I., & Kundera, I. N. (2021). The Effect of Contextual Collaborative Learning Based Ethnoscience to Increase Student s Scientific Literacy Ability. *Turkish Journal of Science Education*, 3. https://doi.org/10.36681/tused.2021.88

Dianjaya, A. R., & Epira, P. (2020). Indonesia Green Economy Implementation Readiness of Greenhouse Gas Emissions Reduction. *Journal of Contemporary Governance and Public Policy*, *1*(1), 27–40. https://doi.org/10.46507/jcgpp.v1i1.5

Frankel, J. R., Wallen, N. E., & Hyun, H. H. (2012). *How to Desigen and Evaluate Reserch in Education*. McGraw-Hill. https://eric.ed.gov/?id=ED323168

Kelp, N. C., McCartney, M., Sarvary, M. A., Shaffer, J. F., & Wolyniak, M. J. (2023). Developing Science Literacy in Students and Society: Theory, Research, and Practice. *Journal of Microbiology & Biology Education*, *24*(2), e00058-23. https://doi.org/10.1128/jmbe.00058-23

López Chao, A., Casares Gallego, A., Lopez-Chao, V., & Alvarellos, A. (2020). Indicators Framework for Sustainable Urban Design. *Atmosphere*, *11*(11), 1143. https://doi.org/10.3390/atmos11111143

Miranti, H., Abdurrahman, & Hasnunidah, N. (2020). Perspective of students' science communication in science learning: Opportunity in developing makerspace STEM learning approach. *Journal of Physics: Conference Series*, *1572*(1), 012049. https://doi.org/10.1088/1742-6596/1572/1/012049

Nasution, R. (2016). Analisis Literasi Lingkungan Siswa SMA Kelas X di Samboja dalam Pembelajaran Biologi. *Prosiding Seminar Nasional XIII Pendidikan BIologi FKIP UNS*, 352–358.

Ningrum, M. A., & Rahmi, Y. L. (2021). Analisis Kebutuhan Penilaian Capaian Literasi STEM Peserta Didik dalam Pembelajaran Biologi. *JURNAL EKSAKTA PENDIDIKAN (JEP)*, *5*(2), 156–163. https://doi.org/10.24036/jep/vol5-iss2/592

Nurbayani, D., Hindriana, A. F., & Sulistyono, S. (2023). Pembelajaran Berbasis Proyek Terintegrasi STEM (PjBL-STEM) Meningkatkan Keterampilan Rekayasa dan Sikap Kewirausahaan. *Quagga: Jurnal Pendidikan dan Biologi*, *15*(1), 54–64. https://doi.org/10.25134/quagga.v15i1.6469

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Available online https://journal.fkip.uniku.ac.id/quagga/index
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Rukoyah, S. O. (2020). *Pembelajaran Berbasis STEM untuk Membangun Keterampilan Rekayasa dan Kemampuan Engineering Productivity Siswa*. Universitas Pendidikan Indonesia.

Sari, N. A., Mulyani, S., Hastuti, B., & Indriyanti, N. Y. (2021). Analysis of High School Students' STEM Literacy and Problem-Solving Skills in Chemistry. *Journal of Physics: Conference Series*, *1842*(1), 012064. https://doi.org/10.1088/1742-6596/1842/1/012064

Simbolon, H., Simbolon, M. R., & Harahap, F. (2019). An Analysis of Students' Scientific Literacy Skills in State Senior High Schools throughout Central Tapanuli District. *Proceedings of the 4th Annual International Seminar on Transformative Education and Educational Leadership (AISTEEL 2019)*. Proceedings of the 4th Annual International Seminar on Transformative Education and Educational Leadership (AISTEEL 2019), Medan City, Indonesia. https://doi.org/10.2991/aisteel-19.2019.22

Stains, M., Harshman, J., Barker, M. K., Chasteen, S. V., Cole, R., DeChenne-Peters, S. E., Eagan, M. K., Esson, J. M., Knight, J. K., Laski, F. A., Levis-Fitzgerald, M., Lee, C. J., Lo, S. M., McDonnell, L. M., McKay, T. A., Michelotti, N., Musgrove, A., Palmer, M. S., Plank, K. M., … Young, A. M. (2018). Anatomy of STEM teaching in North American universities. *Science*, *359*(6383), 1468–1470. https://doi.org/10.1126/science.aap8892

Sukardi. (2008). *Metodologi Penelitian Pendidikan, Kompetensi dan Praktiknya*. PT Bumi Aksara.

Sukarno. (2013). *The Profile of Science Process Skill (SPS) Student at Secondary High School (Case Study in Jambi)*. *1*(1).

Tang, K., & Williams, P. J. (2019). STEM literacy or literacies? Examining the empirical basis of these constructs. *Review of Education*, *7*(3), 675–697. https://doi.org/10.1002/rev3.3162

Thibaut, L., Knipprath, H., Dehaene, W., & Depaepe, F. (2018). The influence of teachers' attitudes and school context on instructional practices in integrated STEM education. *Teaching and Teacher Education*, *71*, 190–205. https://doi.org/10.1016/j.tate.2017.12.014

Utami, K., Surtikanti, H. K., & Rochintaniawati, D. (2023). The profile of students' problem-solving skills toward environmental pollution topic. *Assimilation: Indonesian Journal of Biology Education*, *6*(1), 9–16. https://doi.org/10.17509/aijbe.v6i1.52813

Wahyuni, I. (2019). The Critical Education View of the Modern Community against the Environment. *Proceedings of the 6th International Conference on Community Development (ICCD 2019)*. Proceedings of the 6th International Conference on Community Development (ICCD 2019), Bandar Seri Begawan, Indonesia. https://doi.org/10.2991/iccd-19.2019.66

Widya, Rifandi, R., & Laila Rahmi, Y. (2019). STEM education to fulfil the 21 st century demand: A literature review. *Journal of Physics: Conference Series*, *1317*(1), 012208. https://doi.org/10.1088/1742-6596/1317/1/012208