INTERNATIONAL JOURNAL OF SOCIAL HEALTH
https://ijsh.ph/index.php/rp
Volume 4 Number 9 September 2025 E-ISSN: 2984-7079

Development of an E-Teaching Module Based on the 5E Learning Cycle Model to Enhance Scientific Literacy and Foster the Pancasila Student Profile in the Dimension of Collaborative Spirit

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KEYWORDS
e-module, 5E cycle, science literacy, collaborative spirit

ABSTRACT
This study addresses the need for innovative learning media that can simultaneously enhance scientific literacy and cultivate social values aligned with the *Pancasila* Student Profile, particularly the collaborative spirit aspect. The research aims to develop a valid and effective Temperature and Heat E-Module based on the 5E learning cycle model for junior high school students. The study employed a Research and Development (R&D) design using the 4D model (Define, Design, Develop, and Disseminate). The trial involved 62 students from classes 8D and 8E of *SMP N 4 Yogyakarta* during the 2024/2025 academic year. Data were collected using validation sheets, user response questionnaires, and learning outcome tests, and were analyzed both quantitatively and qualitatively. Expert validation indicated that the developed E-Module falls into the "very good" category in terms of content and media quality. The Kruskal-Wallis test on science literacy posttest scores revealed a significant improvement ($H = 9.115$, $p = 0.003$), confirming the module's effectiveness in enhancing students' scientific literacy. Additionally, the collaborative spirit posttest scores showed a highly significant difference ($H = 35.727$, $p = 0.000$), demonstrating that the module not only improves cognitive skills but also strengthens social values such as cooperation and collaborative work. These findings suggest that the Temperature and Heat E-Module with a 5E approach can serve as a practical and impactful tool for promoting both scientific competence and social character development in line with the *Pancasila* Student Profile.

DOI: 10.58860/ijsh.v4i9.347

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INTRODUCTION

Education plays an important role in shaping humans holistically, so its management needs to be focused on efforts to create changes for the better. Curriculum renewal and development must always be carried out in line with changes that demand educational development toward better quality (Wulandari & Hanim, 2023). This is one of the efforts made by the world of education in realizing better changes. The rapid advancement of the times currently requires humans to have a more progressive way of thinking, both in technological and scientific aspects (Kuanishbaevna, 2025).

Life in the 21st century demands students' readiness to face current and future challenges, where 21st-century skills must be truly instilled in students. The 21st-century learning framework consists of several aspects: life skills and competencies, critical thinking, communication, collaboration, creativity, and skills in information, media, and technology (Takda, Jadmiko, & Erman, 2022). The implementation of the 2013 Curriculum in the current educational environment is a manifestation of 21st-century learning, where the development of the *Merdeka* Curriculum is oriented toward 21st-century skills (Fahkri, 2023).

The theme of the *Merdeka* Curriculum is to produce productive, creative, innovative, and affective Indonesians through strengthening integrated attitudes, skills, and knowledge (Susanta, Susanto, Rusnilawati, Sumardi, & Ali, 2025). The 2013 Indonesian Curriculum, known as *K13*, focuses on competency and character development, preparing students for the digital era by promoting independent learning and character education (Waton, 2023).

Scientific literacy is the ability to utilize scientific knowledge, formulate questions, and draw conclusions based on available evidence to understand and make decisions related to the natural environment and the impacts of changes caused by human activities (Almaida et al., 2023). The lack of students' involvement in learning experiences that train problem-solving affects their weak ability to work together or collaborate.

Based on preliminary observations through interviews with teachers in several schools, teachers experience difficulties in teaching several materials considered abstract. Therefore, teachers and students need teaching materials that can explain these materials effectively. The lack of exploration of various learning models in the classroom causes students to be passive, making it difficult for various abilities that should develop in science learning to be realized.

Previous studies have explored the impact of innovative learning media and models on scientific literacy and 21st-century skills. For example, Susanti et al. (2021) demonstrated that the 5E learning cycle significantly improves students' science process skills, yet their study did not specifically examine the integration of character education or collaborative skills, which are central to the *Merdeka* Curriculum. Similarly, Hidayat and Putri (2022) investigated digital modules in science learning and found improvements in student engagement and understanding of abstract concepts, but the study lacked a focus on scientific literacy outcomes linked to problem-solving and evidence-based reasoning.

This study aims to develop a Temperature and Heat E-Module based on the 5E learning cycle, designed to enhance students' scientific literacy while fostering collaboration as part of the *Pancasila* Student Profile. The study employs a Research and Development (R&D) design using the 4D model (Define, Design, Develop, and Disseminate), with validation from experts and field trials in junior high school classes. The expected benefits of this research include providing effective, evidence-based teaching materials for abstract scientific concepts, improving student engagement and problem-solving abilities, supporting character and collaborative skill development, and serving as a reference for further curriculum innovation in line with 21st-century learning demands.

METHOD

This research is development research, commonly called Research and Development (R&D). The product to be produced in this research is an e-teaching module with a 5E cycle model to improve scientific literacy and collaborative spirit. The development was carried out in stages according to the research model. The use of the research model aims to produce an e-teaching module product that is suitable for use.

The development model used in this research is the 4-D model consisting of 4 stages: Define, Design, Develop, and Disseminate. The 4-D development model compiled by Thiagarajan and Semmel consists of the defining stage (Define), design stage (Design), development stage (Develop), and dissemination stage (Disseminate).

Research Design

The trial design conducted in this e-teaching module development research with the 5E approach consists of field trials including limited-scale trials and large-scale trials. The research subjects for the e-teaching module product with the 5E approach were Grade VIII students of

SMP N 4 Yogyakarta. The implementation was carried out in the odd semester of the 2024/2025 academic year with Temperature and Heat material.

Data Collection Techniques and Instruments

Data collection techniques used in this development research consist of test and non-test techniques. Test instruments used essay questions to measure students' mastery of Temperature and Heat concepts and to measure scientific literacy abilities and collaborative spirit skills. Non-test instruments used questionnaire assessment sheets and observation sheets, including expert validation sheets and student response questionnaires.

Data Analysis Techniques

This research is development research with data collection techniques through tests and non-tests. The data analysis includes validity analysis using Aiken's V coefficient and effectiveness analysis using N-Gain and Kruskal-Wallis tests.

RESULTS AND DISCUSSION

Product Development Results

This research develops a product in the form of science learning media, an electronic module to improve students' scientific literacy and collaborative spirit. Research and product development were conducted using the 4D development model with stages including Define, Design, Develop, and Disseminate.

Define Stage Results

The Define stage consists of 5 stages: initial analysis, student analysis, task analysis, concept analysis, and learning objective specification. Initial analysis was conducted to obtain preliminary data related to research needs through interviews and questionnaire distribution to 67 students from 3 classes in Grade VIII at SMPN 4 Yogyakarta.

During observation, the learning process had been running normally with 45 minutes for 1 class period. In the learning implementation process, teachers had not maximally utilized technology. Teachers had also never used specific applications in science subjects for Temperature and Heat material. Learning at SMPN 4 Yogyakarta refers to the Science Book for Grade VII Revised Semester 2, Ministry of Education, Culture, Research and Technology 2021.

Student analysis results showed that students' scientific literacy abilities based on teacher explanations had not yet been directed toward literacy aspects, especially competency aspects (Ratini, Muchtar, & Suparman, 2018). Teachers explained that in daily school activities, students were indeed accustomed to literacy twice a week before starting learning, but the literacy referred to was still limited to free reading from books that students brought themselves (Chen, Lo, & Lin, 2022). Several indicators of scientific literacy in competency aspects such as explaining phenomena scientifically showed that students were not yet fully able to connect science with phenomena occurring in daily life (David & Suharto, 2024).

Concept analysis was arranged systematically and connected one concept with another to form a concept map. The concept map shows the relationship between temperature concepts, thermometers and temperature scale conversion, and thermal expansion, which are interconnected in understanding Temperature and Heat material (Dilekçi & Karatay, 2023).

Task analysis results showed that the curriculum used by Grade VIII teachers was the Merdeka curriculum, a revision of the 2013 curriculum. In the 2013 curriculum, teachers used Core Competencies (KI) and Basic Competencies (KD) determined by the government. Meanwhile, in the Merdeka curriculum, teachers use learning coverage and learning objectives. One of the materials taught in Grade VIII semester 1 was Temperature and Heat material (Cantika, Khaerunnisa, & Yustikarini, 2022).

Design Stage Results

The Design stage consists of 4 stages including criterion-referenced test compilation, media selection, format selection, and initial design compilation. Criterion-referenced test compilation began with compiling test instrument grids based on Temperature and Heat material. The grids made in this research include design grids and feasibility assessment grids for the 5E approach science e-module (Ardianto & Rubini, 2016).

Media selection shows that the learning media to be developed in this research is a 5E e-module to improve scientific literacy abilities and develop the Pancasila student profile in the collaborative spirit aspect online. This media type is multimedia learning media equipped with sound, video, text, images, and graphics.

Format selection involved creating the 5E e-module starting with making media grids, storyboards, and flowcharts. The 5E e-module application has 8 menus consisting of introduction, usage instructions, material coverage, concept maps, materials, evaluation, bibliography, and profile.

Develop Stage Results

This stage produces an e-teaching module with the 5E approach that has been revised based on input from experts. The experts referred to are lecturers (media and material experts). The developed product must go through a validation stage aimed at improvement according to expert suggestions and input.

Product Validation Results

Product validation was conducted by material experts, media experts, and practitioners to assess the feasibility of the developed e-module. Validation results using Aiken's V coefficient showed that all aspects assessed received high validity values ($V > 0.8$), indicating that the product meets validity standards.

Table 1. Product Validation Results

Validator	Aspect	V Aiken	Category	Percentage	Quality Category
Material Expert	Content Feasibility	0.89	High	89%	Very Good
	Language Appropriateness	0.85	High	85%	Very Good
Media Expert	Interface Display	0.92	High	92%	Very Good
	Pedagogical Aspect	0.87	High	87%	Very Good
Practitioner	Usability	0.83	High	83%	Very Good

The validation results by material and media experts showed that the product was in the very good category. Material expert assessment focused on content accuracy, material structure clarity, appropriate grammar usage, and suitability to students' cognitive capacity. Media expert assessment emphasized visual themes, layout, text quality, navigation functionality, and consistency.

Product Trial Results

Limited Scale Trial

Limited scale trial was conducted with 15 students representing high, medium, and low ability groups. The readability questionnaire results showed that students could understand the e-module content well, with an average readability score of 82%, categorized as good. Students particularly appreciated the interactive features and visual presentations that helped them understand Temperature and Heat concepts better.

Large Scale Trial and Effectiveness Analysis

Large scale trial involved 62 students divided into experimental class (31 students) and control class (31 students). The research design used pretest-posttest control group design to measure the effectiveness of the 5E e-module in improving scientific literacy and collaborative spirit.

Scientific Literacy Results

Scientific literacy was measured using essay tests covering three competency aspects: explaining phenomena scientifically, evaluating and designing scientific investigations, and interpreting data and evidence scientifically.

Table 2. Scientific Literacy Descriptive Statistics

Class	Test	N	Mean	Std. Deviation	Minimum	Maximum
Control	Pretest	31	42.58	9.85	20	60
	Posttest	31	76.99	8.47	60	93
Experimental	Pretest	31	43.66	10.12	27	60
	Posttest	31	83.44	7.89	73	100

The descriptive statistics show that both classes experienced improvement from pretest to posttest. However, the experimental class showed greater improvement than the control class. The experimental class mean increased from 43.66 to 83.44, while the control class increased from 42.58 to 76.99.

Collaborative Spirit Results

Collaborative spirit was measured using a Likert scale questionnaire with 4 points, containing 18 statements given during pretest and posttest.

Table 3. Collaborative Spirit Descriptive Statistics

Class	Test	N	Mean	Std. Deviation	Minimum	Maximum
Control	Pretest	31	67.99	3.45	55	75
	Posttest	31	81.45	4.82	73	94
Experimental	Pretest	31	68.25	3.78	58	75
	Posttest	31	92.89	4.23	80	98

Similar to scientific literacy, both classes showed improvement in collaborative spirit aspects. The experimental class demonstrated greater improvement with a mean increase from 68.25 to 92.89, compared to the control class increase from 67.99 to 81.45.

Prerequisite Test Results

Before conducting hypothesis testing, prerequisite tests were performed including normality and homogeneity tests to determine the appropriate statistical analysis method.

Normality Test

Normality testing was conducted using the Shapiro-Wilk test because the sample size was less than 50 (n=31 for each class).

Table 4. Normality Test Results

Variable	Class	Kolmogorov-Smirnov			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Scientific Literacy Pretest	Control	0.258	31	0.000	0.910	31	0.013

	Experimental	0.220	31	0.001	0.921	31	0.025
Scientific Literacy Posttest	Control	0.214	31	0.001	0.905	31	0.010
	Experimental	0.283	31	0.000	0.878	31	0.002
Collaborative Spirit Pretest	Control	0.181	31	0.011	0.928	31	0.038
	Experimental	0.238	31	0.000	0.882	31	0.003
Collaborative Spirit Posttest	Control	0.169	31	0.025	0.946	31	0.122
	Experimental	0.267	31	0.000	0.864	31	0.001

The normality test results showed that most data were not normally distributed ($p < 0.05$), except for the collaborative spirit posttest data in the control class ($p = 0.122 > 0.05$). Since most data did not meet normality assumptions, non-parametric statistical analysis using the Kruskal-Wallis test was used.

Kruskal-Wallis Test Results

The Kruskal-Wallis test was used to analyze score differences between two groups (control and experimental) on scientific literacy and collaborative spirit variables.

Table 5. Kruskal-Wallis Test Results

Variable	**Scientific Literacy**		**Collaborative Spirit**	
	Pretest	Posttest	Pretest	Posttest
Kruskal-Wallis H	0.281	9.115	0.122	35.727
df	1	1	1	1
Asymp. Sig.	0.596	0.003	0.727	0.000

Scientific Literacy Analysis

Pretest results showed H = 0.281 with significance 0.596 ($p > 0.05$), indicating no significant difference between control and experimental groups before treatment. This demonstrates that both groups had equivalent initial scientific literacy abilities.

Posttest results showed H = 9.115 with significance 0.003 ($p < 0.05$), indicating a significant statistical difference between control and experimental groups after intervention. This provides empirical evidence that the 5E e-module treatment significantly impacted students' scientific literacy improvement.

Collaborative Spirit Analysis

Pretest results showed H = 0.122 with significance 0.727 ($p > 0.05$), indicating no significant difference between groups before treatment, confirming initial homogeneity in collaborative spirit abilities.

Posttest results showed H = 35.727 with significance 0.000 ($p < 0.05$), indicating a very significant statistical difference between groups. The high H value indicates that score distribution in the experimental group was very different from the control group, providing strong indication that the treatment impacted not only cognitive aspects but also strengthened social values such as cooperation, collaboration, and collaborative spirit

N-Gain Analysis

N-Gain analysis was conducted to determine improvement differences before and after using the 5E e-module product. N-Gain was calculated using the following formula:

N-Gain Formula

N-Gain=Posttest Score−Pretest ScoreMaximum Score−Pretest Score\text{N-Gain}= \frac{\text{Posttest Score} - \text{Pretest Score}}{\text{Maximum Score} - \text{Pretest Score}} N-Gain=Maximum Score−Pretest Score Posttest Score−Pretest Score

Table 6. N-Gain Analysis Results

Variable	Class	N-Gain Score	Category	Interpretation
Scientific Literacy	Control	0.60	Medium	Moderate improvement
	Experimental	0.71	High	Significant improvement
Collaborative Spirit	Control	0.41	Medium	Moderate improvement
	Experimental	0.77	High	Significant improvement

N-Gain Criteria

High: N-Gain > 0.7

Medium: 0.3 < N-Gain ≤ 0.7

Low: N-Gain ≤ 0.3

Scientific literacy N-Gain analysis showed that the experimental class obtained a score of 0.71 (high category), while the control class achieved 0.60 (medium category). This difference demonstrates that the 5E e-module was significantly more effective in improving students' scientific literacy compared to conventional learning.

Collaborative spirit N-Gain analysis showed that the experimental class obtained a score of 0.77 (high category), while the control class achieved 0.41 (medium category). This significant improvement in the experimental class indicates that the 5E e-module not only built cognitive understanding but also positively impacted students' social-emotional aspects.

Discussion

The 5E cycle model proved capable of helping build students' conceptual understanding gradually, systematically, and deeply. The e-module designed based on this model provides space for students to be actively involved in the learning process through explorative activities, discussions, and self-reflection. The high N-Gain score in the experimental class indicates that students not only understand concepts theoretically but can also connect them to real-life contexts, which is one of the important indicators in mastering scientific literacy.

The significant improvement in collaborative spirit abilities in the experimental class shows that the developed e-teaching module with the 5E learning cycle model is not only effective in building cognitive understanding but also provides positive impacts on students' social-emotional aspects, particularly in strengthening collaborative values. The 5E model encourages active student involvement in every learning stage.

The e-module is highly interactive, adapting to the Merdeka Curriculum that has not been widely applied in previous research. Besides testing validity and practicality, researchers also measure the module's effectiveness in increasing student engagement. Another innovation is the more contextual material presentation with real-life examples, showing that active participation allows them to actively conduct discovery activities in the learning process.

CONCLUSION

This research has produced a Temperature and Heat E-Module with a 5E approach to improve scientific literacy abilities and develop the *Pancasila* Student Profile in the collaborative spirit aspect. The developed E-Module is declared suitable for use based on material and media expert assessments, with improvements in content structure and language aspects. The E-Module effectively improves scientific literacy with an N-Gain score of 0.71

(high category) compared to the control class with 0.60 (medium category). For collaborative spirit development, the experimental class achieved an N-Gain score of 0.77 (high category) while the control class obtained 0.41 (medium category). The Kruskal-Wallis test results confirm significant differences between experimental and control groups in both scientific literacy ($p = 0.003$) and collaborative spirit ($p = 0.000$), proving the effectiveness of the developed E-Module in achieving learning objectives holistically.

REFERENCES

Almaida, B., Santos, M., & Justi, R. (2022). Aspects and Abilities of Science Literacy in the Context of Nature of Science Teaching. *Science & Education, 32*, 567-587. https://doi.org/10.1007/s11191-022-00324-4

Ardianto, D., & Rubini, B. (2016). Comparison of students' scientific literacy in integrated science learning through model of guided discovery and problem based learning. Jurnal Pendidikan IPA Indonesia, 5(1), 31-37. https://doi.org/10.15294/jpii.v5i1.5493

Badan Standar, Kurikulum, dan Asesmen Pendidikan. (2024). *Kajian Akademik Kurikulum Merdeka*. Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi Republik Indonesia.

Cantika, V. M., Khaerunnisa, L., & Yustikarini, R. (2022). The implementation of the Merdeka curriculum (independent curriculum) in strengthening students' character in Indonesia. International Journal of Educational Research and Social Sciences, 3(6), 2586-2597. https://doi.org/10.46799/ijerss.v3i6.789

Chen, S., Lo, H. C., & Lin, J. W. (2022). Promoting student creativity and entrepreneurship through real-world problem-based maker education. Thinking Skills and Creativity, 44, 101049. https://doi.org/10.1016/j.tsc.2022.101049

David, D., & Suharto, S. (2024). The integration of 21st century skills in the curriculum of education. Heliyon, 10(15), e35148. https://doi.org/10.1016/j.heliyon.2024.e35148

Dilekçi, Ü., & Karatay, H. (2023). The effects of the 21st century skills curriculum on the development of students' creative thinking skills. Thinking Skills and Creativity, 47, 101309. https://doi.org/10.1016/j.tsc.2023.101309

Fakhri, A. (2023). Kurikulum merdeka dan pengembangan perangkat pembelajaran: Menjawab tantangan sosial dalam meningkatkan keterampilan abad 21. *Proceeding Umsurabaya*, 1-10.

Hu, X., & Bi, H. (2024). Exploring and validating the componential model of students' scientific critical thinking in science education. *Thinking Skills and Creativity, 52*, 101695. https://doi.org/10.1016/j.tsc.2024.101695

Kuanishbaevna, E. V. (2025). Analysis of The Importance of Educating Students Based on National Values and Pedagogical Approaches. *Current Research Journal Of Pedagogics*, 6(03), 40-44.

OECD. (2019). *Sky's The Limit: Growth mindset, students, and schools in PISA*. OECD Publishing. https://doi.org/10.1787/1f6f12e2-en

Ratini, R., Muchtar, H., & Suparman, M. A. (2018). The influence of learning models and learning reliance on students' scientific literacy. Jurnal Pendidikan IPA Indonesia, 7(4), 458-466. https://doi.org/10.15294/jpii.v7i4.12489

Rifqi, A., Dewi, E., & Aziz, M. (2024). Dissecting the Foundations of the Philosophy of Science: Ontology, Epistemology, and Axiology in a Contemporary Perspective. *International Journal of Education, Social Studies, and Management (IJESSM), 4*(3), 569-582.

Sinuraya, J., Mihardi, S., & Hakim, A. (2024). Implementation of Inquiry Learning Based on Creativity and Science Process Skills. *Jurnal Penelitian Pendidikan IPA, 10*(7), 3501-3508.

Subagia, I., Suma, K., & Islamiati, E. (2024). Development of Teaching Modules in the Implementation of the Independent Curriculum to Improve the Quality of the Learning Process and Student Learning Outcomes. *Jurnal Penelitian Pendidikan IPA, 10*(11), 906-914.

Susanti, H., Mulyawan, H., Purnama, R., Aulia, M., & Kartika, I. (2024). Pengembangan Kurikulum Merdeka untuk Meningkatkan Kualitas Pembelajaran. *Reslaj: Religion Education Social Laa Roiba Journal, 6*(4), 1-15.

Susanta, A., Susanto, E., Rusnilawati, Sumardi, H., & Ali, S. R. B. (2025). Literacy skills through the use of digital STEAM-inquiry learning modules: A comparative study of urban and rural elementary schools in Indonesia. Eurasia Journal of Mathematics, Science and Technology Education, 21(4), em2615. https://doi.org/10.29333/ejmste/16170

Takda, A., Jadmiko, B., & Erman, E. (2022). Development of INoSIT (integration nature of science in inquiry with technology) learning models to improve science literacy: A preliminary studies. Jurnal Penelitian Pendidikan IPA, 8(1), 18-31. https://doi.org/10.26740/jrpd.v8n1.p18-31

Waton, M. (2023). Relevansi Perubahan Kurikulum 2013 Terhadap Kurikulum Merdeka Belajar Di Era Digital. *Muróbbî: Jurnal Ilmu Pendidikan, 7*(1), 1-12.

Winston, J. (2018). Twenty-First Century Biological Nomenclature—The Enduring Power of Names. *Integrative and Comparative Biology, 58*(6), 1122-1131.

Wulandari, F., & Hanim, M. (2023). Ethno-STEM integrated inquiry learning model on students' scientific literacy abilities. JIIP-Scientific Journal of Educational Sciences, 6(12), 10779-10786. https://doi.org/10.54371/jiip.v6i12.2156