

Development of E-Modules Based on Socio-Scientific Issues to Improve Students' Science Literacy Skills on Temperature and Heat Materials

Risma Mega Silvia^{1,2}, Erina Hertanti¹ and Ahmad Suryadi¹

¹ Program Studi Tadris Fisika UIN Syarif Hidayatullah Jakarta, Jl. Ir H. Juanda No.95, Ciputat, Tangerang Selatan

²E-mail: risma.megasil19@mhs.uinjkt.ac.id

Received: 13 September 2024. Accepted: 4 October 2024. Published: 31 October 2024..

Abstract. E-modules on temperature and heat material have been developed in several studies, but there are still problems. The problem is that it does not facilitate students to practice science literacy skills so it is still relatively low. This research aims to minimize these problems by developing e-modules based on socio-scientific issues to improve students' science literacy skills in temperature and heat materials. The method used is Research and Development with a 4D development design consisting of 4 main stages, namely: Define, Design, Develop and Disseminate. This research is limited to the Develop stage. The e-module testing is feasible through validity, practicality, and effectiveness tests. The test results show that the e-module is suitable for use because it is categorized as valid, practical, and effective. E-modules are categorized as valid with the results of the assessment of excellent material experts, good media experts, and excellent linguists. E-modules are categorized as practical with the results of response questionnaires in small groups, field groups, and teachers showing positive evaluations. E-modules are categorized as moderate or effective in improving students' science literacy skills.

Keywords: E-modules, science literacy, socio-scientific issues

1. Introduction

Along with the sophistication of technology, there are many learning media developed in digital form. One of them is an electronic module or e-module. E-module is a form of presentation of independent teaching materials in electronic format that is designed systematically to achieve certain learning objectives. E-modules are equipped with animations, videos, illustrations, and audio that make the learning process more interactive and add to students' learning experience [1].

Many e-modules have been developed, one of which is in physics lessons such as temperature and heat material. However, e-modules on temperature and heat material are more developed in concept understanding. This is due to the problems that exist in temperature and heat materials. The problem is that temperature and heat materials contain abstract concepts that are difficult for students to learn [2].

This research is intended to develop e-modules on temperature and heat with a new and appropriate design to overcome these problems, namely based on socio-scientific issues. The socio-scientific issues base is new in Indonesia, so socio-scientific issues-based teaching materials have not been widely developed, especially on temperature and heat materials [3]. Socio-scientific issues are related to the presentation of scientific issues that exist in the environment around students and are relevant to real life. Safira [4] states that scientific issues that are relevant and familiar to students will better visualize abstract concepts to make them more concrete. In addition, the socio-scientific issues base can motivate to interpret each content of the material, thus allowing students not to feel difficulties in learning [5].

E-modules based on socio-scientific issues on temperature and heat material in this study aim to improve students' science literacy skills. Science literacy is the ability to apply science by identifying, making decisions, and concluding matters related to science, technology, the environment, and society

[6]. The results of a study conducted by PISA in 2022 stated that the science literacy skills of students in Indonesia were still in the low category even though it had increased by 6 positions from the previous year [7]. According to Reni and Agung [8], there are many factors behind the low science literacy skills of students. One of the factors is the selection of inappropriate learning resources.

The selection of learning resources that only depend on textbooks is less able to attract attention, facilitate, apply, and train students' knowledge and science literacy skills. As a result, students become bored and less able to understand subject matter related to real life [9]. Efforts made to improve science literacy skills are to develop appropriate learning resources in the form of e-modules based on socio-scientific issues that can connect the context of science with real-life problems. This is by Kartika et al. [5] who said that teaching materials designed with socio-scientific issues proved to be able to improve students' science literacy skills. Other opinions also say that the use of teaching materials designed with socio-scientific issues can significantly improve students' science literacy skills [10].

2. Methods

This research uses the development method of Research and Development. The development design used is the 4D model developed by S. Thiagarajan, D S. Semmel, and Melvyn I. Semmel. The 4D development model consists of 4 main stages, namely: Define, Design, Develop, and Disseminate [11]. This research is limited to the Develop stage. These stages are described in Figure 1.

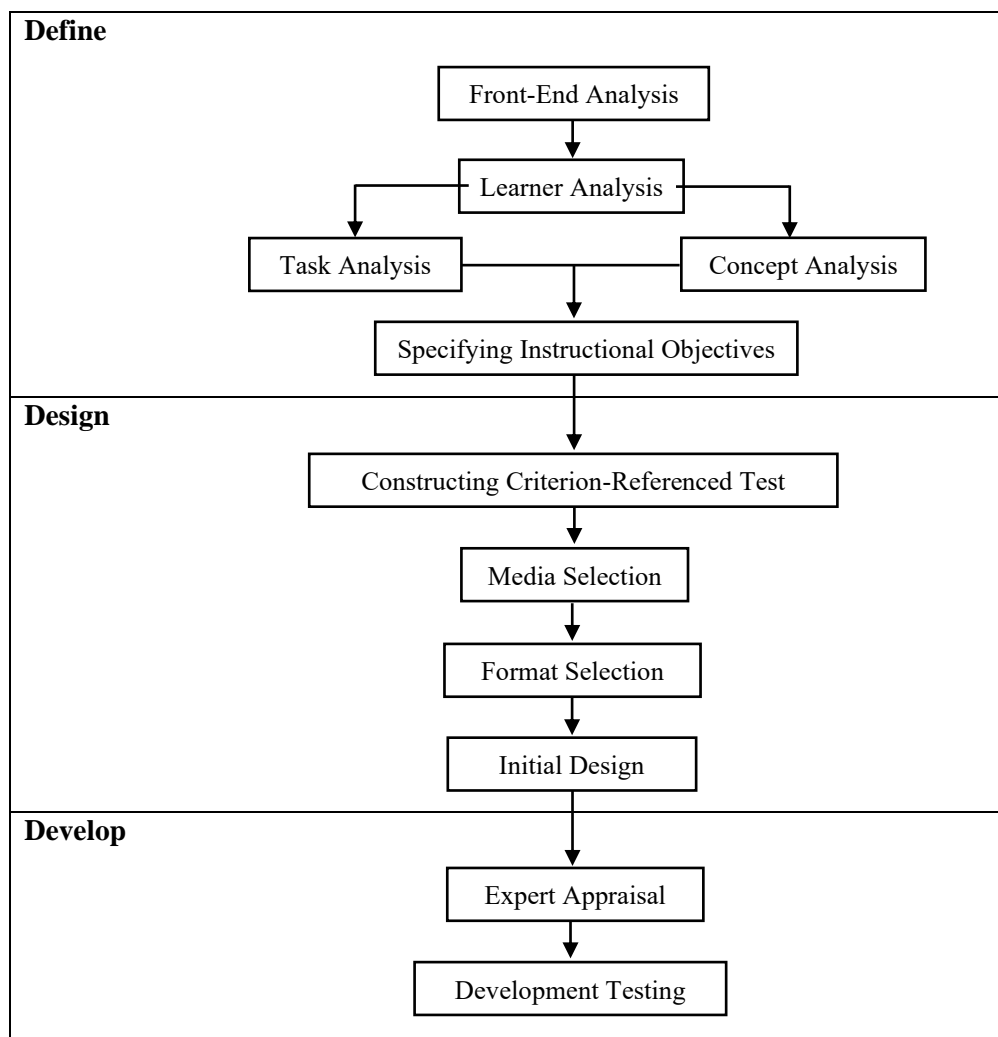


Figure 1: Stages of the 3D Development Model reduced from the 4D developed by S. Thiagarajan, et. al.

The define stage aims to determine the requirements and needs needed in the development through teacher interview guidelines, student preliminary study questionnaires, and literature studies. The teacher interview guidelines and the preliminary study questionnaire used open-ended questions. The open-ended questions contain basic problems that occur in the physics learning process, student characteristics, and needs. There were 2 physics teachers interviewed and 68 students who filled out the preliminary study questionnaire. The grids of the interview guidelines and the preliminary study questionnaire are described in Table. 1

Table 1. Grid of interview guidelines and preliminary study questionnaires.

Question Indicator	No. Question Item	Number of Questions
Implementation of physics learning in the classroom	1	1
Science literacy skills in learning	2,3	2
Use of learning media in class	4,5,6	3
Total		6

The literature study includes activities to analyze several previous studies related to the design of e-modules based on socio-scientific issues. One of them is the results of Dania Eka Putri's research which shows that the socio-scientific issues-based e-module developed is included in the category worth using and is effective in improving students' science literacy skills [12].

The design stage aims to design the initial design of the developed e-module. The design of e-modules based on socio-scientific issues in this study consists of three parts, namely the introduction, the core part, and the closing part. In the introduction section, the e-module presents instructions for use, learning outcomes, learning objectives, and concept maps. In the core section, the e-module presents learning activities based on the socio-critical and problem-oriented stages developed by Eilks et al. The learning stages developed by Eilks et al. [13] consist of textual approach and problem analysis, clarification of science background through practicum, continuing the socio-scientific dimension, discussion and evaluation with different viewpoints, and meta-reflection. The socio-critical and problem-oriented learning stages meet the criteria and are by socio-scientific issues base.

In the core activities at the textual approach and problem analysis stage, the e-module presents news along with questions about temperature and heat material that has existed in the surrounding environment to be read and understood by students. For example, the news entitled, "The Dangers of Mercury Thermometers which are Banned Starting 2020". After that, a column is presented for students to answer the questions given. At the stage of clarifying the scientific background through practicum, the e-module presents activities containing practicum on temperature and heat material. At the stage of continuing the socio-scientific dimension, the e-module presents instructions to direct students to find and analyze news or articles related to temperature and heat material. It is intended that students can strengthen their opinions in debate activities in the next stage. At the discussion and evaluation stage with different points of view, the e-module presents problem topics related to temperature and heat. For example, a topic about the pros and cons of mercury thermometers that are still in use is presented. Students are divided into pro and contra groups and directed to conduct online debates with applications that are already available in the e-module. At the meta-reflection stage, the e-module presents a column for students to make conclusions about the learning activities that have been carried out [14]. In the closing section, the e-module presents a summary of the core material and a glossary.

The develop stage aims to modify the e-module design into a valid, practical, and effective final version. The validity of the e-module can be seen from the results of the expert test questionnaire. The practicality of e-modules can be seen from the results of teacher and student response questionnaires. The effectiveness of the e-module can be seen from the results of the N-gain score obtained by students after working on the test instrument. The test instrument consists of 15 questions related to temperature and heat material with science literacy indicators according to PISA 2018 [15].

The research was conducted in two high schools located in Jakarta, namely SMAN 106 and SMA Budhi Warman 2. The research trial subjects consisted of experts, students, and teachers as described in Table 2.

Table 2: Trial subjects.

Stage	Test Subject
Expert Validity Test	9 lecturers (3 material experts, 3 media experts, and 3 language experts).
Small Group Trial	9 students of class XI of SMAN 106 Jakarta have studied temperature and heat material.
Field Trial	30 students of class XI SMA Budhi Warman 2 Jakarta who have never learned about temperature and heat. 2 physics teachers of SMAN 106 Jakarta and SMA Budhi Warman 2 Jakarta.

Data analysis conducted in the study:

1. Teachers' interview guidelines and students' preliminary study questionnaires were analyzed using qualitative descriptive methods [16]. The qualitative descriptive method is to analyze, describe, and summarize various conditions and situations from the data results regarding the problem under study [17].
2. Expert test questionnaires were analyzed using quantitative methods with the calculation of TCR (Respondent Achievement Rate). From the TCR results, the validity value of the e-module is obtained. The percentage and category of TCR results are described in Table 3.

Table 3. Percentage and category of TCR.

Percentage	Category
81,26% - 100%	Very Valid
62,51% - 81,25%	Valid
43,76% - 62,50%	Fairly Valid
25,01% - 43,75%	Invalid

3. Student and teacher response questionnaires were analyzed using quantitative methods with Data Analysis Tools from the official UEQ (User Experience Questionnaire) website. From the results of Data Analysis Tools, the practicality value of the e-module is obtained. The levels and categories of the Data Analysis Tools results on UEQ are described in Table 4.

Table 4. UEQ levels and categories [18].

Level	Category	Interpretation
> 0,8	Positive Evaluation	Very Practical to Use
-0,8 to 0,8	Normal Evaluation	Practical Use
< -0,8	Negative Evaluation	Not Practical to Use

4. The test instrument was analyzed using quantitative methods by comparing the pretest and posttest scores through the acquisition of N-gain. From the N-gain results, the effectiveness of the e-module can be obtained. The N-gain score and criteria can be seen in Table 5.

Table 5. N-gain score criteria [19].

Score	Criteria
$g > 0,7$	High
$0,7 \leq g \leq 0,3$	Medium
$g < 0,3$	Low

3. Results and Discussion

The results of this study provide information that a product has been produced in the form of an e-module designed based on socio-scientific issues. The e-module is categorized as valid, practical, and effective in improving students' science literacy skills on temperature and heat material. This research uses the 4D development design according to S. Thiagarajan which consists of the Define, Design, Develop stages. The description of the research results and discussion at each stage is described as follows:

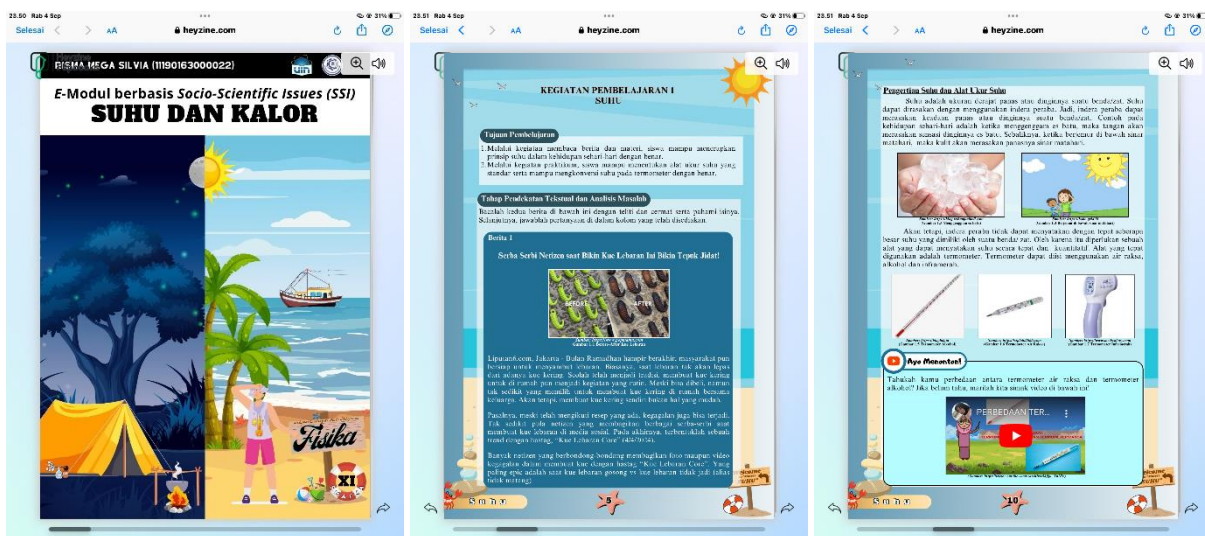
3.1. Define Stage

The Define stage provides information about the results of interview guidelines and student preliminary study questionnaires. The results show that almost all students have difficulty learning physics, teachers who teach only use printed modules and power points and students' science literacy skills are in the low category. To overcome these problems, innovation is needed by developing a learning media in the form of e-modules based on socio-scientific issues to improve students' science literacy. Laraphaty et al, [20] said that the use of e-modules can help students who have learning difficulties and make it easier to understand the content of the material in a structured and systematic manner. The results of Nur'aida Afrilya's research [10] stated that the socio-scientific issues base can motivate students to interpret each content of learning materials and can significantly improve students' science literacy skills. The results of other literature studies also show that the average e-modules designed with socio-scientific issues are categorized as valid, practical, and effective for use in learning.

3.2. Design Stage

The Design stage provides information about the results of the initial e-module design. Before designing e-modules, several things must be considered, namely preparing tests that refer to criteria, media selection, and format. The preparation of tests refers to the criteria aimed at designing questions based on science literacy indicators according to PISA 2018. Media and format selection aims to select media platforms and formats that are relevant to the characteristics of the material, e-module content design, and student needs. The selected media platforms are Canva Pro and Heyzine while the selected format uses the e-module framework according to the Directorate of High School Development, Directorate General of Primary and Secondary Education.

The initial design of the e-module must be done before the development trial is conducted. The snippet of the results of the initial e-module design can be seen in Figure 2.



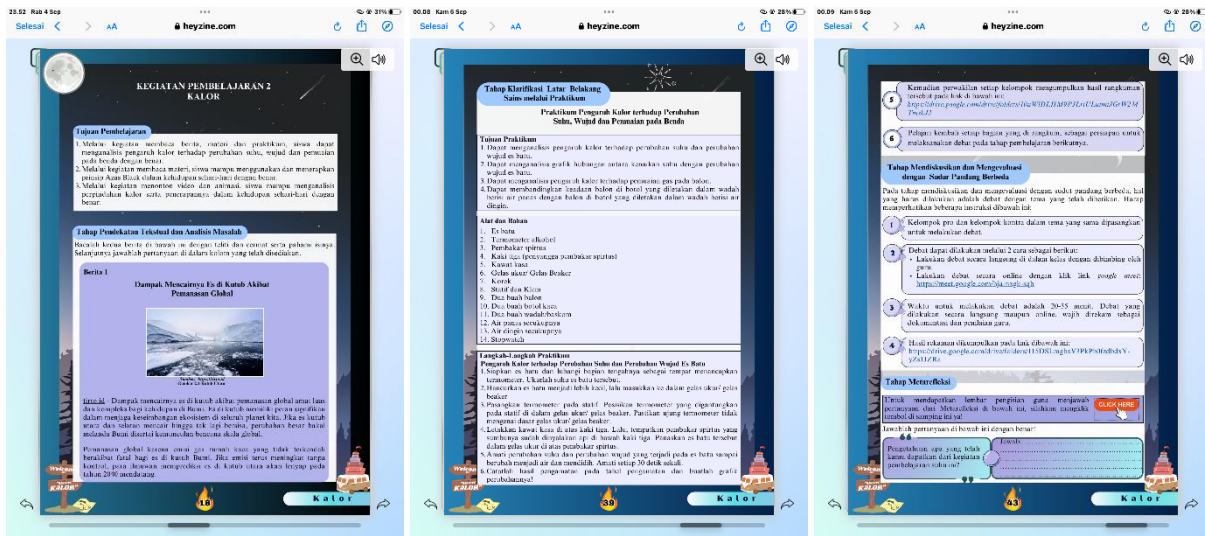


Figure 2. Snapshot of E-Module Preliminary Design Results

3.3. Develop Stage

The Develop stage provides information about the results of e-module validity in expert validity activities as well as the results of the practicality and effectiveness of e-modules in development trials. Expert validity is an assessment conducted by 3 media experts, 3 material experts, and 3 language experts. The description of the results of expert validity is as follows.

Table 6. Material expert assessment results.

Aspects	Score Result	Max Value	TCR (%)	Category
Content Feasibility	60	60	100	Very good
Self-Study	59	60	98,33	Very good
Average			99,17	Very good

Table 7. Media expert assessment results.

Aspects	Score Result	Max Value	TCR (%)	Category
Presentation Feasibility	35	45	77,78	Good
Media Effects on Learning Strategies	38	45	84,44	Very good
Feasibility of Comprehensive Display	92	120	76,67	Good
Average			78,57	Good

Table 8. Results of language expert assessment.

Aspects	Score Result	Max Value	TCR (%)	Category
Language Feasibility	149	150	99,33	Very good
Average			99,33	Very good

From the results of Tables 6, 7, and 8, it can be concluded that the e-module is categorized as valid based on the results of expert assessment in terms of material, media, and language. In terms of material, the content on the e-module has been well designed according to the established curriculum meets the latest knowledge, and is relevant to temperature and heat material. According to Nieveen, learning media can be said to be valid if the material is well designed according to the curriculum, the material components must be based on the latest knowledge and interconnected [21].

In terms of media, e-modules can store and present information in the form of writing, images, and videos and there are interactive quizzes and several links that are easily accessed by students in one view. In addition, e-modules are designed so that students can learn independently so that they can streamline learning time. According to Gerlach and Ely in Ili [22], the characteristics of learning media that are valid and feasible to use in learning are fulfilling the elements of fixative, manipulative, and

distributive. Fixative is the media's ability to record, store, and reconstruct a learning event/object. Manipulative is the media's ability to streamline time well. Distributive is the ability of the media to display various objects to be transformed through an integrated display.

In terms of language, the e-module uses straightforward, interactive, communicative sentences and is by Indonesian language rules. According to the Directorate of High School Development [23] one of the principles of developing a good e-module is using semi-formal language that is communicative and interactive.

Development trials were conducted in small groups and the field. The small group trial aims to determine the practical value of the e-module developed from the results of the student response questionnaire. The results of the response questionnaire in the small group trial are described in Table 9.

Table 9. Results of small group student response questionnaire.

UEQ Scale	Results	Description
Attractiveness	1,78	Positive evaluation
Clarity	1,75	Positive evaluation
Efficiency	1,75	Positive evaluation
Accuracy	1,69	Positive evaluation
Stimulation	1,75	Positive evaluation
Novelty	1,72	Positive evaluation
Average	1,74	Positive evaluation

From Table 9, it can be concluded that the average results of the response questionnaire in the small group showed a positive evaluation. This means that the e-module developed is categorized as practical for use in learning.

Field group trials were conducted to know the value of e-module practicality from the results of student and teacher response questionnaires and the effectiveness of e-modules from the N-gain results. The results of student and teacher response questionnaires in the field trial are described in Table 10 and Table 11.

Table 10. Field group student response questionnaire results.

UEQ Scale	Results	Description
Attractiveness	1,62	Positive evaluation
Clarity	1,74	Positive evaluation
Efficiency	1,45	Positive evaluation
Accuracy	1,48	Positive evaluation
Stimulation	1,41	Positive evaluation
Novelty	1,28	Positive evaluation
Average	1,50	Positive evaluation

Table 11. Field group teacher response questionnaire results.

UEQ Scale	Results	Description
Attractiveness	3,00	Positive evaluation
Clarity	2,88	Positive evaluation
Efficiency	2,75	Positive evaluation
Accuracy	2,38	Positive evaluation
Stimulation	2,75	Positive evaluation
Novelty	2,63	Positive evaluation
Average	2,73	Positive evaluation

From Tables 10 and 11, it can be concluded that the average results of the response questionnaire in the field group show a positive evaluation. This means that the e-module developed is categorized as practical for use in learning.

The e-module is categorized as practical because the average results of the student and teacher response questionnaire assessment in Tables 9, 10, and 11 with the UEQ scale aspects show a positive evaluation. The aspect of the UEQ scale that gets the highest score is in the attractiveness and clarity section. This shows that e-modules based on socio-scientific issues are liked, interactive, easy to use, and understood by students and teachers. According to Nieveen [21], learning media can be said to be practical if its users, especially students and teachers, rate the developed product as easy to use and can describe the learning process.

The N-gain results in the field trial are described in Table 12.

Table 12. N-gain result table.

Science Literacy Indicators	N-Gain	Category
Explaining Phenomena Scientifically	0,52	Medium
Evaluating and Designing Scientific Inquiry	0,62	Medium
Interpreting Data and Evidence Scientifically	0,66	Medium
Content	0,78	High
Procedural	0,47	Medium
Epistemic	0,48	Medium
Average	0,56	Medium

Table 12 shows that the e-module is categorized as moderate and effective because it shows an increase in the average N-gain results of students' science literacy skills. This can be seen from the increase in students' science literacy test results between before and after using the e-module. This is in line with the results of Dania's research [12] Where the use of e-modules based on socio-scientific issues as learning media is effective for improving science literacy skills. According to Arip & Aswat [24], learning materials delivered using interactive media are more effective than not using media.

4. Conclusion

Based on the results of the research and discussion, it can be concluded that a product has been developed in the form of an e-module designed based on socio-scientific issues to improve students' science literacy skills in temperature and heat materials. The e-module is also categorized as valid, practical, and effective in improving students' science literacy skills. Future researchers are advised to try to measure students' scientific argumentation skills because at the stage of discussing and evaluating different points of view, there are discussion forums and debates that can facilitate students' scientific argumentation skills.

Acknowledgments

The author would like to thank all those who have helped in the process of this research, especially the lecturers of the Tadris Physics Study Program of UIN Syarif Hidayatullah Jakarta, physics teachers, and grade XI students from SMAN 106 Jakarta and SMA Budhi Warman 2 Jakarta.

References

- [1] Hakim L N, Wedi A and Praherdhiono H 2020 Electronic Module (E-Module) Untuk Memfasilitasi Siswa Belajar Materi Cahaya dan Alat Optik Di Rumah *Jurnal Kajian Teknologi Pendidikan* **3** 239–50
- [2] Wahab R, Saprudin S and Achmad R 2023 E-Modul Interaktif Materi Kalor untuk Meningkatkan Hasil Belajar Siswa Sekolah Menengah Pertama *Jurnal Luminous: Riset Ilmiah Pendidikan Fisika* **4** 33–8
- [3] Nofrianto R 2021 Pengembangan Lembar Kegiatan Peserta Didik (LKPD) Berbasis Socio-Scientific Issues Pada Pelajaran IPA Untuk Menumbuhkan Kemampuan Berpikir Kritis Peserta Didik Kelas VII SMP
- [4] Safira N A 2021 Pengembangan Instrumen Asesmen Literasi Sains Berbasis Socioscientific Issues (SSI) Pada Materi Pencemaran Lingkungan

- [5] Kartika I, Kurniasih S and Pursitasari I D 2019 Pengembangan bahan ajar berbasis socio-scientific issues pada materi bioteknologi untuk meningkatkan literasi sains siswa *Journal of Science Education and Practice* **3** 1–12
- [6] Toharudin U, Rahmiati D, Fazriyah N and Hendrayana S 2023 *Literasi Sains Pendekatan Pembelajaran Kontemporer* (Depok: Raja Grafindo)
- [7] Kebudayaan K P 2023 Peringkat Indonesia pada PISA 2022 Naik 5-6 Posisi Dibanding 2018
- [8] Kristiyowati R and Purwanto A 2019 Pembelajaran Literasi Sains Melalui Pemanfaatan Lingkungan *Scholaria: Jurnal Pendidikan dan Kebudayaan* **9** 183–91
- [9] Fuadi H, Robbia A Z, Jamaluddin J and Jufri A W 2020 Analisis Faktor Penyebab Rendahnya Kemampuan Literasi Sains Peserta Didik *Jurnal Ilmiah Profesi Pendidikan* **5** 108–16
- [10] Afrilya N A 2020 Pengaruh Penerapan Pendekatan Socio Scientific Issues (SSI) Terhadap Kemampuan Literasi Sains Siswa pada Materi Minyak Bumi
- [11] Thiagarajan S, Semmel S D and Semmel I M 1974 *Instructional Development for Training Teachers of Exceptional Children: A Sourcebook*
- [12] Dania E K A P 2022 Pengembangan E-Modul Biologi Berbasis Socio-Scientific Issues (Ssi) Untuk Meningkatkan Literasi Sains Pada Materi Perubahan Lingkungan Kelas X Sman 16 Bandar Lampung
- [13] Marks R, Stuckey M, Belova N and Eilks I 2014 The societal dimension in German science education - from tradition towards selected cases and recent developments *Eurasia Journal of Mathematics, Science and Technology Education* **10** 285–96
- [14] Purwanto A, Rahmawati Y, Rahmayanti N, Mardiah A and Putri R A 2022 Socio-critical and problem-oriented approach in environmental issues for students' critical thinking skills development in Chemistry learning *JOTSE* **12** 50–67
- [15] OECD 2019 *PISA 2018 Assessment and Analytical Framework*
- [16] Sugiyono 2013 *Metode Penelitian Kuantitatif, Kualitatif dan R&D* (Bandung: ALFABETA)
- [17] Mulia Z. Faizal 2022 Implementation of Organizational Culture on Village Owned Enterprises (BUMDes) Village Karangpapak Cisolok Subdistrict Sukabumi District *Jurnal Ilmu Manajemen Retail Universitas Muhammadiyah Sukabumi* **3**
- [18] Amarulloh R R 2022 Pengembangan Media Pembelajaran Fisika Dasar Berbasis Literasi Sains dengan Menggunakan Google Sites *Jurnal Inovasi dan Pembelajaran Fisika* **9** 154–64
- [19] Syahfitri M M 2008 *Analisa Unsur Hara Fosfor (P) pada Daun Kelapa Sawit secara Spektrofotometri di Pusat Penelitian Kelapa Sawit (PPKS) Medan* (Medan: Universitas Sumatera Utara)
- [20] Laraphaty N F R, Riswanda J, Anggun D P, Maretha D E and Ulfa K 2021 Pengembangan Media Pembelajaran Modul Elektronik (E-Modul) *Prosiding Seminar Nasional Pendidikan Biologi* vol 4 pp 145–56
- [21] Nieveen N 1999 *Design Approaches and Tools in Education and Training*
- [22] Ili L 2019 *Ragam Media Pembelajaran di Sekolah Dasar* (Jawa Timur: CV Penerbit Qiara Media)
- [23] Direktorat Pembinaan SMA et. al 2017 *Panduan Praktis Penyusun E-Modul*
- [24] Arip M and Aswat H 2021 Media pop up book untuk meningkatkan hasil belajar siswa pada mata pelajaran ipa di sekolah dasar *Edukatif: Jurnal Ilmu Pendidikan* **3** 261–8