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DEVELOPMENT E-LKPD INTERACTIVE BASED ON SOCIO SCIENTIFIC ISSUES (SSI) ON CLIMATE CHANGE TO FACILITATE STUDENT'S CRITICAL THINKING

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Abstract: This research was conducted against the background of the low critical thinking of students in Indonesia which can be overcome by the socio scientific issues (SSI) approach by connecting science with social issues such as climate change. With the SSI approach, E-LKPD makes learning more interactive, increases student involvement and overcomes teacher-centered learning. The purpose of this study was to determine the development process of interactive E-LKPD based on socio scientific issues (SSI). The research method used is R&D with 4-D research model modified with the define, design, and development stages. This research has developed an interactive E-LKPD based on socio scientific issues (SSI) on climate change material to facilitate students' critical thinking in digital form through the help of the live worksheets website which is categorized as very feasible. The results of material expert validation obtained a percentage of 93.8% which was categorized as very feasible and the results of media expert validation obtained a parentage of 89.2% which was also categorized as very feasible. Student responses to the E-LKPD readability test was 90.8% which was classified as high.
Keywords: E-LKPD; Socio Scientific Issues; Climate Change; Critical Thinking.

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Introduction

The quality of education in various countries, including Indonesia, can be measured through the results of surveys conducted by the Program for International Student Assessment (PISA) which is an important reference in measuring the quality of education. The results of the 2022 PISA survey show that Indonesia's literacy learning outcomes ranking has increased by 5 to 6 positions compared to 2018 (Kemendikbud RI, 2023). However, Indonesia's science literacy score in PISA 2022 was 383 which is still below the international average score of 500 (OECD, 2023). The low science literacy in Indonesia is a serious concern and can affect the quality of student learning in schools.

Critical thinking skills with science literacy skills show a correlation between indicators (Kusumastuti et al., 2019). A person's critical thinking ability can be influenced by their level of science literacy. Students with low science literacy show that students still have difficulty in developing reasoning skills, and are

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not used to reading with critical thinking, and still have difficulty in making decisions to solve existing problems (Utomo et al., 2020). This is due to the need for a deep understanding of scientific concepts and processes, as well as the ability to interpret information and make informed decisions. Increasing science literacy through the development of critical thinking can strengthen awareness in the understanding and application of science in everyday life (Azrai et al., 2020).

Teacher-centered learning, where students are only focused on the material without any initiative to ask questions and be actively involved in learning, causes students' critical thinking skills to remain low and not develop (Agus, 2019). Effective learning is student-centered learning because students take an active role during learning (Sahertian & Hidayati, 2022). But in reality, learning in schools still dose not involve students in playing an active role in solving problems.

Critical thinking skills are essential abilities for students and have a significant role in education, especially in science learning such as physics (Amelia & Chusni, 2024). Critical thinking skills really need to be developed in physics learning, because this ability can strengthen students' analytical skills in solving problems (Prihandono et al., 2023). Physics is a branch of science that studies natural phenomena and events that occur in everyday life (Saputra et al., 2020).

The development of appropriate learning resources is essential to achieve educational goals and develop various skills needed. In fact, learning in Indonesian schools is still teacher-centered and uses the lecture method, which makes students less active during the learning process (Zahroh & Yuliani, 2021). This has impact on the process of developing students' critical thinking skills and makes it difficult to apply differences in abilities between students. Therefore, the use of inappropriate learning tools is one of the causes of not achieving education goals (Al Mukarram et al., 2014).

Education that is relevant to future needs requires a well-designed system that can cope with changes that occur (Al Mukarram et al., 2014). One way to improve students' critical thinking skills is through variations in the learning process, such as using learning media such as LKPD (Elfina & Sylvia, 2020). To meet the needs of innovative and interactive LKPD in developing students' critical thinking, E-LKPD was developed. In addition, LKPD also plays role in helping students acquire process skills, scientific attitudes, and interest in the environment. E-LKPD are LKPD that are modified into files that can be accessed electronically (Nababan & Putri, 2022). In addition, E-LKPD content is more diverse, such as audio, music, animation, video, and links, not only in the form of narratives, images, and graphics as in printed LKPDs (Sirmayeni, 2023).

The socio scientific issues (SSI) learning model can develop students' critical thinking skills. SSI represents social issues related to science (Sirmayeni, 2023). The SSI approach can develop students' critical thinking skills because it integrates science concepts that have an impact on people's lives. SSI raises actual issues that occur in society and encourages students to discuss and find solutions (Sirmayeni, 2023). Climate change is one of the environmental issues relevant to physics learning using the SSI approach (Nazilah et al., 2019). The SSI approach in physics learning can facilitate students to connect physics concepts with daily life phenomena.

Climate change is a global environmental problem caused by human activities, both directly and indirectly (Rahmah, 2022). Understanding climateoo change is very important for the society and students. The extreme impact of climate change on humans and the earth is not only caused by climate phenomena, but also by sensitivity to the biophysical environment (Holden et al., 2022). Analysis of critical thinking skills in physics learning helps students improve their ability to assess information, identify problems, and find innovative solutions (Mahardika et al., 2023).

Based on results of the analysis conducted at one of the SMANs in Tangerang Regency, it shows that physics learning, especially on climate change material is less

interactive and interesting and there is no application of E-LKPD based on socio scientific issues (SSI). Therefore, the development of interactive E-LKPD based on socio scientific issues (SSI) on climate change material is carried out to facilitate students' critical thinking.

Method

This study uses the Research and Development (RnD) method. The purpose of the RnD approach is to develop new products, which in this study is to develop interactive E-LKPD based on socio scientific issues (SSI) on climate change material to facilitate students' critical thinking. The research model used is the 4-D model, which consists of defining, designing, developing, and disseminating stages.

The E-LKPD readability trial was conducted in the odd semester of the 2024/2025 academic year at SMAN 6 Tangerang Regency to determine student's responses to the information presented in the E-LKPD. The subjects of this study were 39 students of class XI of SMAN 6 Tangerang Regency. Before conducting a trial to students, the E-LKPD product was validated by validators. This validation process involved 4 experts, namely material and media experts. Validation from both experts is very important to ensure the quality and effectiveness of E-LKPD in learning and assess the feasibility of the product.

This research procedure uses four stages, namely define, design, develop, and disseminate.

Define

At this stage, identifying current issues in physics learning, especially on climate material, to understand the challenges faced, such as the lack of interactivity and student interest, and the absence of SSI based E-LKPD implementation. In addition, students' needs analyzed by using E-LKPD as a tool to support the development of students' critical thinking skills.

Design

At this stage, an analysis is conducted to design the design and content of interactive E-LKPD content, tailored to the characteristics of students and learning objectives. This design analysis aims to determine important components in the E-LKPD, such as interactive elements, SSI-based, and materials that can support the development of students, critical thinking skills, as well as provide solutions to the problems identified at the define stage.

Develop

At this stage, product development is carried out as a result of the define and design stages. The development process includes making materials, designing interactive displays, and integrating SSI which is linked to indicators of critical thinking skills. After that, the E-LKPD product was validated by material and media experts to ensure its quality and feasibility. Based on the input and assessment from the validators, improvements were made until the product was considered ready to be tested and suitable for distribution. The validation results determine the extent of the feasibility of the products produced in this study.

Disseminate

At this stage, the results of product development are disseminated after going through the define, design, and develop stages. The interactive E-LKPD that has been made is then tested by giving the E-LKPD to students. Students will then provide feedback on the use of E-LKPD, as part of the product dissemination and evaluation process.

The research instruments consisted of material expert instrument, media expert instrument, and student readability test questionnaires for interactive E-LKPDs. The material expert instrument, based on the modified National Education Standards Agency (BSNP) reference, consists of content, presentation, contextual and language feasibility. The media expert validation instrument, also based on the modified BSNP reference, consists of the size, cover of the E-LKPD, and language rules. The student readability test instrument was applied based on aspects consisting of the appearance and readability of the E-LKPD,

material content and relevance to climate change, socio scientific issues (SSI) approach, learning engagement and motivation, and satisfaction and recommendations. The data collection technique used a validation questionnaire given to material and media experts, as well as a student readability test questionnaire for E-LKPD. The team of material and media experts consisted of 4 people, namely 2 lecturers and 2 physics teachers, while the respondents consisted of 39 students aimed at measuring the readability of interactive E-LKPD media.

In this study, data analysis was conducted using quantitative and qualitative approaches to evaluate the development of E-LKPD. Data obtained from the validation questionnaire of material and media experts, as well as student responses were analyzed using a qualitative descriptive approach. Meanwhile, quantitative data was used to assess the quality of materials and media. The analysis was carried out by calculating the aspects relevant to the problem being analyzed. The data analysis techniques used include Likert scale and Guttman scale. Data obtained from a team of material and media experts were analyzed using a Likert scale, while data obtained from student readability tests were analyzed using a Guttman scale. The test scores using the Likert scale can be found in Table 1, while the test scores using the Guttman scale can be seen in Table 2.

Table 1. Score Criteria for Material Experts and Media Experts

Score	Criteria
1	Very good
2	Good
3	Simply
4	Less
5	Very less

(Bahak Udin By Arifin & Aunillah, 2021)

Table 2. Student Response Score Criteria

Score	Criteria
0	No
1	Yes

(Iskani, 2015)

The rating scale obtained is then processed into a percentage using the following equation:

After obtaining the percentage results, the interpretation of the suitability assessment scale based on the suitability test is then carried out in Table 3 and Table 4.

Table 3. Interpretation of Criteria for Material Experts and Media Experts

Assessment	Interpretation Criteria
81%-100%	Very Feasible
61%-89%	Worth
41%-60%	Less Feasible
21%-40%	Not Feasible
<20%	Very Unfit

Table 4. Interpretation of Readability Test Assessment Criteria

Assessment	Interpretation Criteria
67,71%	High

34,36%-66,71& 33,36	Medium Low

Results and Discussion

Define

Climate change is currently one of the most widely discussed environmental issues and is considered a global challenge. Climate change occurs due to human activities, both directly and indirectly. The impact is not only influenced by climate phenomena, but also by the level of awareness and concern for the environment. Therefore, an understanding of climate change is very important for the community, including students. One of the obstacles in learning is the lack of interactivity, which contributes to students' low interest in the material. Conventional learning methods, such as lectures, make students less actively involved, so concept understanding becomes less optimal.

One of the efforts to improve student understanding is to develop interactive learning media, such as LKPD which is modified into Socio Scientific Issues (SSI) based E-LKPD. E-LKPD based on SSI is not only an interactive and innovative learning, but also to help students in developing process skills, scientific attitudes, and interest in the environment. Through SSI, students are invited to discuss various issues, analyze their impact, and find relevant solutions. However, to date, the development of SSI-based E-LKPDs, especially on climate change material, is still limited. Therefore, the development of E-LKPD integrated with SSI in climate change material aims to facilitate students' critical thinking skills.

Design

The E-LKPD developed in this study is based on Socio Scientific Issues (SSI) and is designed to support students' critical thinking skills on climate change material. There are two main topics in this E-LKPD, namely, the increasingly alarming impacts of climate change and climate change mitigation with a focus on the threat of drought in Banten.

This SSI-based E-LKPD is made using the www.liveworksheets.com platform which can be accessed via pc/laptop or smartphone with active internet conditions. The material is presented in the form of interactive electronic books that can be filled in directly, providing a learning experience similar to printed books. In addition, the E-LKPD is supported by images and videos that can increase students' understanding of the material. Further display of the SSI-based E-LKPD can be seen in the figure below.

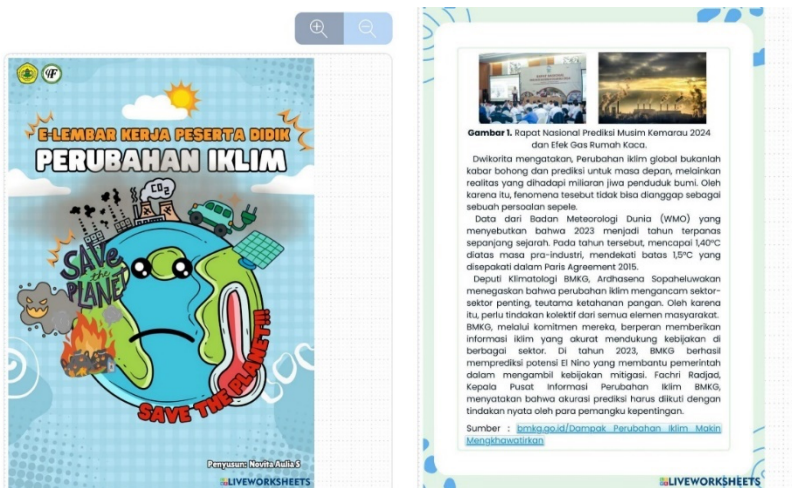

Figure 1 and 2. E-LKPD display with the topic of the increasingly alarming impacts of climate change on the liveworksheet platform.

Figure 3 and 4. Display of E-LKPD on the topic of climate mitigation with a focus on the threat of drought in Banten on the live worksheet platform.

Develop

At the development stage, material and media validation were conducted for teaching materials to determine their feasibility. Based on the results of the four validators, the results of the feasibility questionnaire for the material can be seen in Figure 5 and the feasibility results for the media can be seen in Figure 6.

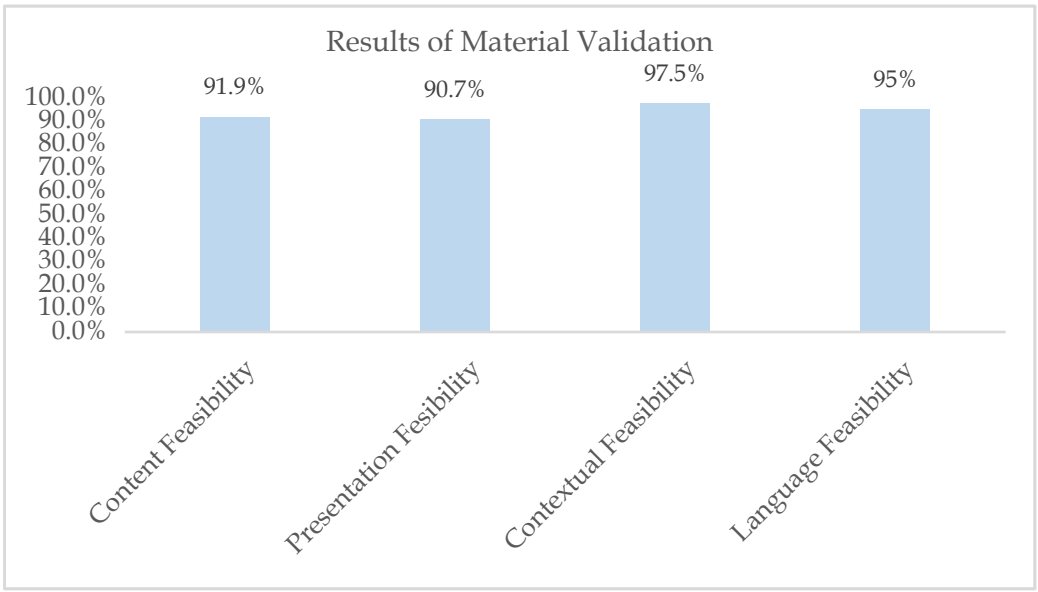

Figure 5. Diagram of Material Validation Results

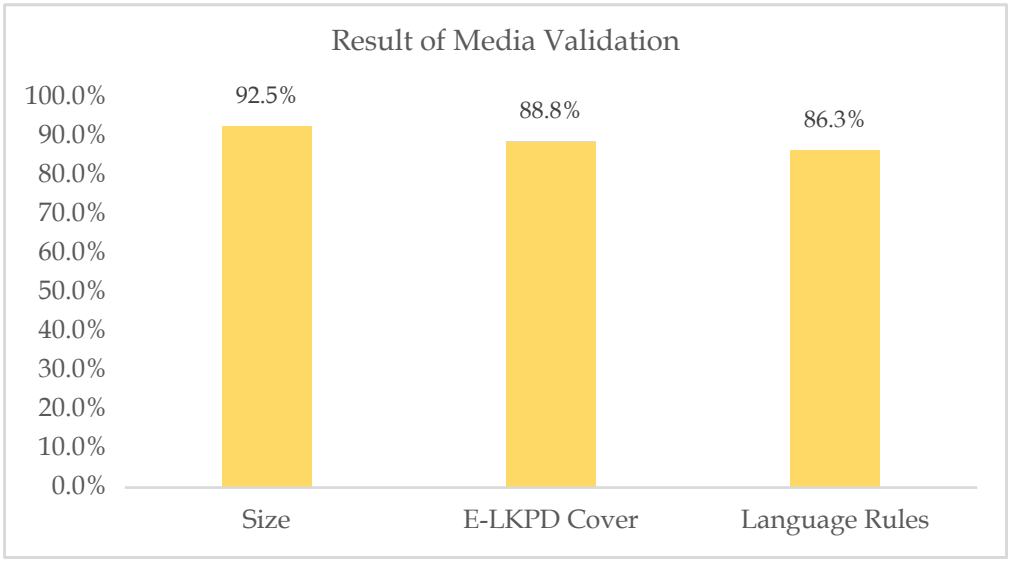

Figure 6. Diagram of Media Validation Results

Based on the results of validation conducted by four validators, the results of the assessment of the material showed a very high level of feasibility. The content feasibility aspect obtained a score of 91.9%, presentation feasibility of 90.7%, contextual feasibility of 97.5%, and language feasibility of 95% with all aspects in the "very feasible" category. Ind addition, media validation also showed high results, where the size aspect received a score of 92.5%, the E-LKPD cover pf 88.8%, and the language rules of 86.3%, all of which were also categorized as "very feasible".

Furthermore, the product was revised based on the suggestions and input from the validators. After that, a readability trial was conducted on students, where they filled out a questionnaire to assess the level of acceptance of the interactive E-LKPD. This readability trial involved 39 students of class XI SMA Negeri 6 Tangerang Regency. The assessment was conducted based on 5 main aspects, namely, aspects of the appearance and readability of E-LKPD to assess the visual design, layout, structure of E-LKPD, as well as ease of understanding and reading comfort for students; aspects of material content and relevance to climate change to measure the suitability of the material with the concept of climate change; aspects of *socio scientific issues* (SSI) approach to evaluate how E-LKPD connects science with real social issues, and encourages students' analysis, solution seeking, and critical thinking; aspects of learning engagement and motivation to assess the extent to which E-LKPD can increase students' active participation in learning; and aspects of satisfaction and recommendations to measure students' experience in using E-LKPD and provide input for further development. The results of the student readability trial can be seen in Figure 7.

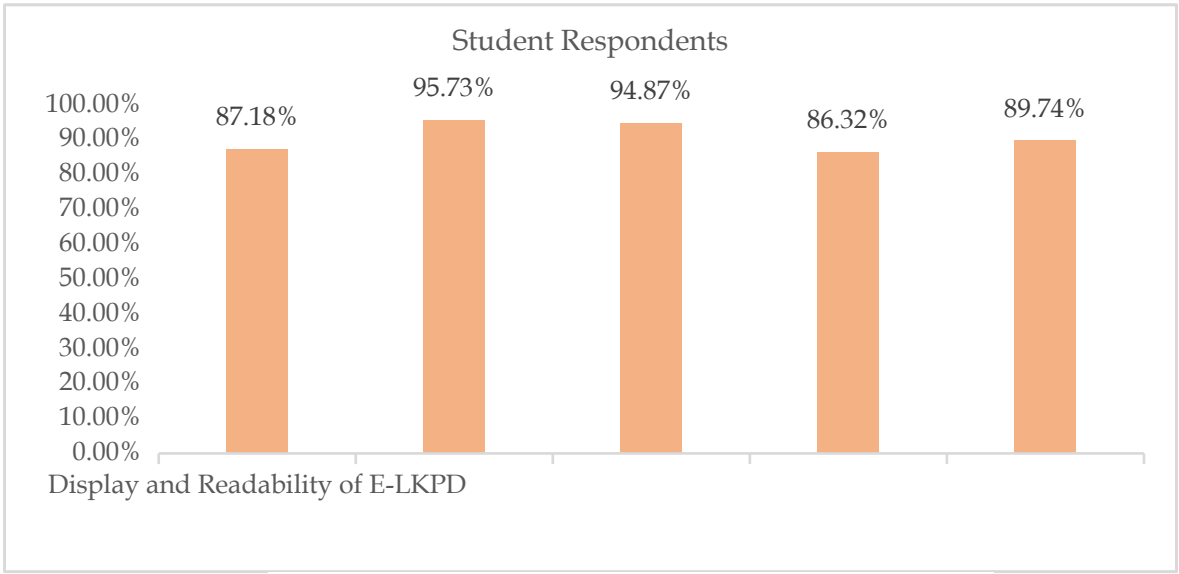

Figure 7. Results of Readability Test for Student Respondents

From the aspect of appearance and readability of E-LKPD, the result is 87.18% with high category; the aspect of material content and relevance to climate change is 95.73% with high category; the aspect of *socio scientific issues* (SSI) approach is 94.87% with high category; the aspect of learning involvement and motivation is 86.32% with high category; and the aspect of satisfaction and recommendation is 89.74% with high category.

The suitability of this SSI-based E-LKPD is based on the results of material and media expert validation, as well as student responses to the readability of E-LKPD for students in learning. At the validation stage, suggestions for improvement were given for improving sentence structure, descriptions in the observation table, cover resolution, font size, and use of foreign languages. The results of the E-LKPD assessment can be seen in Table 5 for material validation and Table 6 for media validation.

Table 5. Average Material Expert Validation Results

Validator Name	Content Feasibility	Presentation Feasibility	Contextual Feasibility	Language Feasibility	Validator Average
Validator 1	92,5%	88,6%	90%	100%	92,8%
Validator 2	92,5%	94,3%	100%	100%	96,7%
Validator 3	95%	94,3%	100%	90%	94,8%
Validator 4	87,5%	85,7%	100%	90%	90,8%
Total Average	91,9%	90,7%	97,5%	95,0%	93,8%

Table 6. Average Media Expert Validation Results

Validator Name	Size	Cover E-LKPD	Grammar Rules	Validator Average
Validator 1	100%	87,5%	85%	90,8%
Validator 2	100%	90%	90%	93,3%
Validator 3	80%	85%	80%	81,7%
Validator 4	90%	92,5%	90%	90,8%
Total Average	92,5%	88,8%	86,3%	89,2%

Based on the assessment of the material validator, the average result is 93.8% with a very feasible category. In the media validation results, an average result of 89.2% was obtained with a very feasible category. After the validation of material experts and media experts on the SSI-based interactive E-LKPD, a readability trial was conducted to 39 students

to determine student responses to the E-LKPD. The average result obtained was 90.8% with a high category, can be seen in Table 7.

Table 7. Average Results of Student Readability Test Respondents on E-LKPDs

Display and Readability of E-LKPDs	Content and Relevance to Climate Change	Socio Scientific Issues (SSI) approach	Engagement and Motivation to Learn	Satisfaction and Recommendation	Average
87,18%	95,73%	94,87%	86,32%	89,74%	90,8%

The overall assessment of the E-LKPD is summarized in Table 8.

Table 8. Overall Assessment of E-LKPD

Assessment	Score (%)	Description
Material Validation	93,8%	Very suitable
Media Validation	89,2%	Very suitable
Student Readability Test	90,8%	Very suitable
Average	91,3%	Very suitable

The results of the overall assessment of the E-LKPD show an average percentage of 91.3% which is included in the very suitable category. Thus, the SSI-based interactive E-LKPD on climate change material is considered feasible and can be utilized in learning physics class X Independent Curriculum high school to support the development of students' critical thinking skills.

Conclusion

The development of interactive E-LKPD based on socio scientific issues (SSI) on climate change material to facilitate students' critical thinking was carried out through modified 4D stages, namely *defining, designing, and developing*. The climate change content in this interactive E-LKPD is integrated with the stages of *socio scientific issues* (SSI). In its implementation, this interactive E-LKPD uses *liveworksheets* website media

The feasibility of E-LKPD was assessed based on material and media expert validation and student readability test. Validation was carried out by 4 material and media experts, namely 2 lecturers and 2 physics teachers, while the readability test respondents were 39 students. The results of the material expert validation obtained an average percentage of 93.8% with a very feasible category, while the media expert validation obtained an average percentage of 89.2% which was also in the very feasible category. Suggestions and input from the validators have been analyzed and revised before being tested on students.

Students' responses to the E-LKPD covered 5 aspects, namely the appearance and readability of the E-LKPD 87.18%, the content and relevance to climate change 95.73%, the *socio scientific issues* (SSI) approach 94.87%, the involvement and motivation to learn 86.32%, and the satisfaction and recommendation 89.74%. Overall, the average percentage of student assessment obtained 90.8% which was categorized as very feasible. The SSI-based interactive E-LKPD on climate change achieved a high feasibility rating 91.3%, indicating its potential for effective implementation in high school physics education. Future research could explore its long-term impact on student problem solving skills and conceptual understanding. And the SSI-based interactive E-LKPD on the topic of climate change can be used in learning class X high school physics in the independent curriculum to support the development of students' critical thinking skills.

References

Agus, I. (2019). Efektivitas guided discovery menggunakan pendekatan kontekstual ditinjau dari kemampuan berpikir kritis, prestasi, dan self-efficacy. *Jurnal Riset Pendidikan Matematika*, *6*(2), 120–132. https://doi.org/10.21831/jrpm.v6i2.14517

Al Mukarram, A., Hartini, S., & Wati, M. (2014). Pengembangan Lembar Kegiatan Siswa (LKS) dan Media Pembelajaran IPA SMP Berbasis Keterampilan Berpikir Kritis. *Jurnal Berkala Ilmiah Pendidikan Fisika*, *2*(3), 253–264.

Amelia, N., & Chusni, M. M. (2024). Analisis Keterampilan Berpikir Kritis Dalam Pembelajaran Fisika Pada Materi Energi Terbarukan. *BIOCHEPHY: Journal of Science Education*, *4*(1), 248–252. https://doi.org/10.52562/biochephy.v4i1.1114

Azrai, E. P., Suryanda, A.-, Wulaningsih, R. D., & Sumiyati, U. K. (2020). Kemampuan Berpikir Kritis Dan Literasi Sains Siswa Sma Di Jakarta Timur. *Edusains*, *12*(1), 89–97. https://doi.org/10.15408/es.v12i1.13671

Bahak Udin By Arifin, M., & Aunillah. (2021). Buku Ajar Statistik Pendidikan. In *Forum Statistika dan Komputasi* (Vol. 8, Issue 1).

Elfina, S., & Sylvia, I. (2020). Pengembangan Lembar Kerja Peserta Didik (LKPD) Berbasis Problem Based Learning (PBL) dalam Meningkatkan Kemampuan Berpikir Kritis Siswa Pada Mata Pelajaran Sosiologi di SMA Negeri 1 Payakumbuh. *Jurnal Sikola: Jurnal Kajian Pendidikan Dan Pembelajaran*, *2*(1), 27–34. https://doi.org/10.24036/sikola.v2i1.56

Holden, P. B., Rebelo, A. J., Wolski, P., Odoulami, R. C., Lawal, K. A., Kimutai, J., Nkemelang, T., & New, M. G. (2022). Nature-based solutions in mountain catchments reduce impact of anthropogenic climate change on drought streamflow. *Communications Earth and Environment*, *3*(1), 1–12. https://doi.org/10.1038/s43247-022-00379-9

Iskani, D. (2015). Pengukuran Skala Guttman Secara Tradisional (Cross-Sectional). *Ejournal Poltektegal*, 5. http://ejournal.poltektegal.ac.id

Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi Republik Indonesia. (2023). Peringkat Indonesia pada PISA 2022 naik 5-6 posisi dibanding 2018. https://www.kemdikbud.go.id/main/blog/2023/12/peringkat-indonesia-pada-pisa-2022-naik-56-posisi-dibanding-2018

Kusumastuti, R. P., Rusilowati, A., & ... (2019). Pengaruh Keterampilan Berpikir Krtis Terhadap Literasi Sains Siswa. *UPEJ Unnes Physics …*, *8*(3). https://journal.unnes.ac.id/sju/index.php/upej/article/view/35624%0Ahttps://journal.unnes.ac.id/sju/index.php/upej/article/view/35624/14662

Mahardika, I. K., Sari, E., Handono, S., Aqilla, S. L., Faruqi, R., Ramadani, A., & Al-Jufri, Z. (2023). Hakikat dan Fungsi Sains Dalam Pembelajaran Fisika. *INNOVATIVE: Journal of Social Science Research*, *3*(6), 3955–3964.

Nababan, S. T., & Putri, D. H. (2022). Analisis Kebutuhan E-LKPD Terhadap Pembelajaran Fisika Di Masa Pandemi Covid-19. *JIPFRI (Jurnal Inovasi Pendidikan Fisika Dan Riset Ilmiah)*, *6*(1), 32–40. https://doi.org/10.30599/jipfri.v6i1.1199

Nazilah, N., Muharrami, L. K., Rosidi, I., & Wulandari, A. Y. R. (2019). Pengaruh Bahan Ajar Berbasis Socio-Scientific Issues Pada Materi Pemanasan Global Untuk Melatih Kemampuan Literasi Sains Siswa. *Natural Science Education Research*, *2*(1), 8–16. https://doi.org/10.21107/nser.v2i1.4162

OECD. (2023). PISA 2022 Results Factsheets Indonesia. *OECD (Organisation for Economic Co-Operation and Development) Publication*, 1–9. https://www.oecd.org/en/publications/pisa-2022-results-volume-i-and-ii-country-notes_ed6fbcc5-en/indonesia_c2e1ae0e-en.html

Prihandono, T., Supriyono, A., Mailina, I. L., & Ernasari, E. (2023). Penerapan E-LKPD Interaktif Berbasis Problem Based Learning Berbantuan Liveworksheets untuk Meningkatkan Kemampuan Berpikir Kritis dan Hasil Belajar Fisika. *Jurnal Pembelajaran Fisika*, *12*(3), 114. https://doi.org/10.19184/jpf.v12i3.43462

Rahmah, D. M. (2022). Perubahan Iklim Dalam Pendidikan Ipa Berkelanjutan. *Jurnal Sains Edukatika Indonesia*, *4*(2), 20–25.

https://jurnal.uns.ac.id/jsei/article/download/70940/39614

Sahertian, D. P., & Hidayati, S. N. (2022). Analisis Keterampilan Pemecahan Masalah Siswa Berbantuan Artikel Socio-Scientific Issue Pada Materi Energi Alternatif. *Pensa E-Jurnal : Pendidikan Sains* , *10*(1), 1–7. https://ejournal.unesa.ac.id/index.php/pensa

Saputra, S., Jumadi, & Wilujeng, I. (2020). Physics based learning effectiveness PhET simulation model using Problem Based Learning (PBL) for self-independent learning on material and energy enterprises learners MAN 3 Sleman. *Journal of Physics: Conference Series*, *1567*(3), 1–7. https://doi.org/10.1088/1742-6596/1567/3/032097

Sirmayeni. (2023). Analisis Kemampuan Befikir Kritis Peserta Didik dengan E-LKPD Berbasis Socioscientific Issues (SSI) pada Pembelajaran Kimia. *Prosiding Nasional Pendidikan: LPPM IKIP PGRI Bojonegoro*, 174–183.

Utomo, A., Narulita, E., & Billah, R. (2020). Penerapan model pembelajaran problem based learning berbasis socio- scientific issue (SSI) terhadap kemampuan berpikir kritis siswa SMP. *JIPVA (Jurnal Pendidikan IPA Veteran)*, *4*(2), 148–159. http://e-journal.ivet.ac.id/index.php/jipva

Zahroh, D. A., & Yuliani. (2021). *Berkala Ilmiah Pendidikan Biologi*. *10*(3), 605–616.