BioEdu
Berkala Ilmiah Pendidikan Biologi
Vol. 14 No. 3 Tahun 2025 Hal: 691-698
https://ejournal.unesa.ac.id/index.php/bioedu

VALIDITY AND PRACTICALITY OF ELECTRONIC STUDENT WORKSHEET (E-LKPD) INTEGRATED WITH THE HANDS ON MINDS ON APPROACH ON ENVIRONMENTAL CHANGE MATERIAL TO TRAIN THE CRITICAL THINKING SKILLS OF GRADE X SENIOR HIGH SCHOOL STUDENTS

Validitas Dan Kepraktisan Lembar Kerja Peserta Didik Elektronik (E-LKPD) Terintegrasi Hands On Minds On pada Materi Perubahan Lingkungan untuk Melatih Berpikir Kritis Peserta Didik Kelas X SMA

Deswita Ardyagarani
Biology Education, Faculty of Mathematics and Natural Sciences, Surabaya State University
E-mail: deswitaardyagarani.21006@mhs.unesa.ac.id

Herlina Fitrihidajati
Biology Education, Faculty of Mathematics and Natural Sciences, Surabaya State University
E-mail: herlinafitrihidajati@unesa.ac.id

Abstract

21st-century education requires students to possess critical thinking skills to face global challenges and solve problems effectively. In the context of biology learning, especially on environmental change material, these skills are essential and should be developed through innovative and interactive learning media. This study aims to develop an Electronic Student Worksheet (E-LKPD) integrated with the Hands On Minds On approach to enhance the critical thinking skills of Grade X students. The measured parameters include product validity and practicality. Validity was assessed based on content, language, and presentation, while practicality was evaluated through student responses and learning implementation, using critical thinking indicators such as interpretation, analysis, inference, evaluation, explanation, and self-regulation. The research employed a Research and Development (R&D) method using the 4D model: define, design, develop, and disseminate. The limited trial involved 34 students from Class X-10 at SMA Negeri 16 Surabaya. Data analysis was conducted using descriptive quantitative techniques by calculating percentages, implementation scores, and student response scores. The results showed that the developed E-LKPD achieved an average validity percentage of 98.15% (very good), an implementation score of 100% (very high), and a positive student response of 99.06% (very high). These results indicate that the E-LKPD integrated with the Hands On Minds On approach is feasible to be used as an innovative teaching material in biology learning, particularly in the environmental change topic.
Keywords: E-LKPD, Hands On Minds On, critical thinking, environmental change.

Abstrak

Pendidikan abad 21 menuntut peserta didik memiliki keterampilan berpikir kritis guna menghadapi tantangan global dan menyelesaikan masalah secara efektif. Dalam konteks pembelajaran biologi, khususnya pada materi perubahan lingkungan, keterampilan ini menjadi penting untuk dikembangkan melalui media ajar yang inovatif dan interaktif. Penelitian ini bertujuan untuk mengembangkan Lembar Kerja Peserta Didik Elektronik (E-LKPD) terintegrasi Hands On Minds On pada materi perubahan lingkungan untuk melatih keterampilan berpikir kritis peserta didik kelas X SMA. Parameter yang diukur meliputi validitas dan kepraktisan produk. Validitas ditinjau dari aspek isi, bahasa, dan penyajian, kepraktisan ditinjau dari respon peserta didik dan keterlaksanaan pembelajaran berdasarkan indikator berpikir kritis yang mencakup interpretasi, analisis, inferensi, evaluasi, eksplanasi, dan regulasi diri. Penelitian ini menggunakan metode Research and Development (R&D) dengan model 4D yang terdiri atas tahapan define, design, develop, dan disseminate. Subjek uji coba terbatas adalah 34 peserta didik kelas X-10 di SMA Negeri 16 Surabaya. Teknik analisis data dilakukan secara deskriptif kuantitatif dengan mengukur persentase, skor keterlaksanaan, dan skor respon peserta didik. Hasil penelitian menunjukkan bahwa E-LKPD yang dikembangkan memperoleh rata-rata persentase sebesar 98,15% (sangat baik). Kepraktisan produk dari keterlaksanaan pembelajaran mencapai 100% (sangat tinggi) dan respon positif peserta didik sebesar 99,06% (sangat tinggi). Berdasarkan hasil tersebut, E-LKPD terintegrasi Hands On Minds On dinyatakan layak digunakan sebagai bahan ajar inovatif dalam pembelajaran biologi, khususnya pada materi perubahan lingkungan.
Kata Kunci: *E-LKPD, Hands On Minds On, berpikir kritis, perubahan lingkungan.*

INTRODUCTION

Education plays a fundamental role in shaping high-quality human resources who are capable of thinking critically, creatively, and logically, as well as collaborating to address global challenges. In the context of national education, the implementation of the Merdeka Curriculum is a strategic step toward fostering 21st-century competencies, such as higher-order thinking and problem-solving skills (Ramdani & Badriah, 2018). This curriculum emphasizes student-centered learning approaches, in contrast to previous models that were more focused on teacher-centered content delivery (Indarta *et al.,* 2022).

However, various challenges remain in the effective implementation of learning in schools. One of the main issues is the low level of students' critical thinking skills. Many teachers still emphasize cognitive achievement, where success is measured by exam scores and memorization rather than deep, analytical thinking processes. This focus has led to a lack of critical thinking abilities an essential competency for facing real-world problems. A study by Agnafia (2019) reported that students' average critical thinking score was only 54.17%, which is considered low. Moreover, interviews with biology teachers at SMA Negeri 16 Surabaya revealed that students continue to struggle with deep conceptual understanding and tend to be passive during learning activities.

The lack of critical thinking skills not only affects academic performance but also hinders students' abilities in problem-solving, decision-making, and logical reasoning. Critical thinking involves competencies such as interpreting information, analyzing arguments, evaluating evidence, drawing inferences, explaining reasoning, and self-regulating thought processes (Syamsi & Fitrihidajati, 2021). Therefore, there is a need for innovative and contextual learning approaches that promote active student engagement and support optimal cognitive development.

One such approach is the Hands On Minds On method, which combines physical engagement (hands-on) with cognitive reflection (minds-on). This method has been shown to enhance students' participation and conceptual understanding through practical activities, authentic problem-solving, and direct exploration of relevant phenomena (Yannier *et al.,* 2021). Key components such as collaboration, information processing, and decision-making contribute to the holistic development of critical thinking skills. The Hands On Minds On approach aligns with the principles of the Merdeka Curriculum and the Pancasila Student Profile, which emphasize student autonomy and inclusive learning.

In the context of skill-oriented learning, the development of instructional materials plays a crucial role. Student worksheets, particularly in digital form (E-LKPD), offer a strategic alternative to facilitate interactive, flexible, and technology-based learning experiences. When developed using the Hands On Minds On approach, E-LKPD can incorporate features such as Bio Think, Bio Activity, and Bio Exercises that are specifically designed to train critical thinking skills through problem-based exploratory and reflective tasks (Nisa & Fitrihidajati, 2024; Sari & Susantini, 2023).

The choice of learning material also significantly influences the development of these skills. The topic of Environmental Change, part of the Grade X Biology curriculum under the Merdeka Curriculum, is highly relevant for integrating problem-solving and critical analysis in learning. Core competencies in this topic demand not only conceptual understanding of environmental phenomena but also the ability to formulate solutions to real-world environmental problems (Permendikbud, 2016). Moreover, this material aligns closely with the Sustainable Development Goals (SDGs), particularly Goals 4 and 13 Quality Education and Climate Action highlighting the role of education in cultivating environmentally conscious individuals who are prepared to act for a sustainable future (UNESCO, 2020).

Based on the aforementioned rationale, this study aims to develop an Electronic Student Worksheet (E-LKPD) integrated with the Hands On Minds On approach for the topic of Environmental Change, with the goal of enhancing the critical thinking skills of Grade X senior high school students. This research is expected to contribute a contextual, interactive, and student-relevant learning resource that effectively improves the quality of biology education.

Furthermore, the outcomes of this research are not limited to product development; they are also expected to provide practical guidance for teachers in implementing innovative teaching approaches that support the systematic and sustainable development of students' critical thinking skills.

METHODS

This study employed a research and development (R&D) design, adopting the 4D development model

(Define, Design, Develop, Disseminate) proposed by Thiagarajan. In the Define stage, curriculum analysis, student characteristics, subject matter concepts, and learning objectives were examined to identify instructional needs and challenges. The Design stage involved the development of an Electronic Student Worksheet (E-LKPD) integrated with the Hands On Minds On model, based on the analysis results. This phase included the formulation of content, features, and the instruments to be used.

In the Develop stage, the product underwent validation by a media expert, a subject matter expert, and a biology teacher. Revisions were made according to the feedback received. The revised product was then tested in a limited trial involving 34 Grade X students at SMA Negeri 16 Surabaya over three sessions: (1) introduction to concepts and a pre-test, (2) hands-on eco-enzyme making activity, and (3) presentation of results (minds-on) followed by a post-test. The final stage, Disseminate, focused on refining and distributing the product to a broader user base.

The population of this study consisted of all students in class X-10 at SMA Negeri 16 Surabaya, with a limited sample of one homogeneous class (34 students). Data collection techniques included validation, implementation observation, and student response questionnaires. Instruments used in this study comprised validation sheets, observation sheets, and student response questionnaires. Validation was conducted by three experts using a Likert scale ranging from 1 to 4, categorized from “very valid” to “not valid” (Riduwan, 2016). A score was considered valid if the percentage of validity reached ≥ 75%. Learning implementation was observed by four observers during the instructional process, and questionnaires were distributed at the end of the learning sessions.

The data collected were analyzed using descriptive quantitative methods. Validation scores were averaged and interpreted using the Likert scale, while student responses were analyzed using the Guttman scale. Evaluation was carried out by marking the "Yes" column if the activity was implemented and approved, or "No" if it was not implemented or not approved. Observational data were analyzed based on the percentage of implementation of the learning syntax.

The developed product consisted of an E-LKPD designed using the Canva platform, integrated with Liveworksheet. It featured components such as Bio Think, Bio Fact, Bio Activity, Bio Concept, Bio Link, and Bio Exercise. Materials used in the practicum included organic waste in the form of banana peels and 4% yeast concentration for the production of eco enzyme as an application of the environmental change concept.

RESULTS AND DISCUSSION

The result of this development research is an Electronic Student Worksheet (E-LKPD) integrated with the Hands On Minds On approach, specifically designed for the topic of environmental change to train students' critical thinking skills. The study produced several types of data: the developed E-LKPD product, validity results (as assessed by subject matter and media experts), and practicality results (based on the implementation of the E-LKPD, observation of student activity, and student response data).

Hands On Minds On Integrated E-LKPD

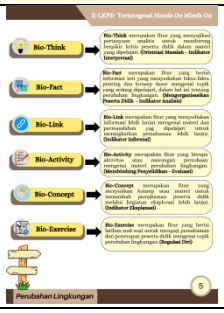
The E-LKPD developed in this study was purposefully designed to cultivate six indicators of critical thinking skills as proposed by Facione interpretation, analysis, inference, evaluation, explanation, and self-regulation. These indicators were embedded within learning activities aligned with the Hands On Minds On approach, which emphasizes students' active engagement both physically through experiments (hands-on) and cognitively through reflection and analysis (minds-on).

To support the achievement of these critical thinking indicators, the E-LKPD features several interactive components, including Bio Think prompts contextual guiding questions to stimulate students’ critical thinking processes, Bio Fact presents brief scientific articles and readings to provide a basis for analysis and interpretation, Bio Link provides hyperlinks or QR codes to access additional learning resources such as videos or articles, facilitating further exploration and self-regulation, Bio Activity offers a practicum activity on eco-enzyme production, aimed at developing inference and evaluation skills through real-life application, Bio Concept summarizes the core environmental change concepts in a structured manner to reinforce conceptual understanding., and Bio Exercise includes problem-based practice questions that strengthen students’ analytical and explanatory skills.

The integration of these features not only enhances students' understanding of the subject matter but also transforms the E-LKPD into an effective medium for contextual and applicable critical thinking skill development.

BioEdu
Berkala Ilmiah Pendidikan Biologi
Vol. 14 No. 3 Tahun 2025 Hal: 691-698
https://ejournal.unesa.ac.id/index.php/bioedu

Table 1. Profile and Supporting Features of E-LKPD

No.	Profile and Features	Description
1		Front cover and back cover of E-LKPD
2		Display of explanation of E-LKPD features that integrate Hands On Minds On approach syntax and critical thinking skills
3		Bio Think, this feature engages students in reading a short article summarizing environmental pollution material, specifically focusing on the issue of organic waste in Indonesia. Students are encouraged to formulate questions related to the problems presented in the article, fostering their ability to identify and interpret issues critically
4		Bio Fact, this feature presents interesting facts in the form of articles or concise readings related to environmental phenomena, particularly organic waste pollution. It aims to enrich students' knowledge and provide scientific context that supports further analysis and understanding of the issue
5		Bio Link, this feature provides access to external websites that students can visit to obtain additional information related to the topic of waste and environmental pollution. It serves as a resource to support independent exploration and deepen students' understanding of real-world environmental issues
6		Bio Activity, his feature functions as a practical implementation tool that supports hands-on learning activities. It enhances students' understanding of the material, encourages active participation, and promotes collaboration through an eco-enzyme making project using organic waste as the main ingredient
7		Bio Concept, this feature consists of a concise summary of the environmental change material designed to reinforce students' conceptual understanding and support the consolidation of key ideas
8		Bio Exercise, this feature contains practice questions designed to develop students' critical thinking skills, including analytical questions related to environmental change phenomena. It also guides students in presenting the results of their practicum activities by communicating their eco-enzyme product outcomes

The features embedded in this E-LKPD were carefully designed based on the syntax of the Hands On Minds On approach and critical thinking skill indicators. This design aligns with the findings of Rahmadani and Anugraheni (2017), who emphasized that the Hands On Minds On approach focuses on developing problem-solving abilities through the construction of contextual, real-life problems. The approach is also consistent with the syntax of Problem Based Learning (PBL), which includes stages such as problem identification, planning, and both independent and collaborative investigation. Furthermore, this approach encourages students to produce and present a final product as a learning outcome, thereby sharpening their critical thinking and problem-solving skills.

Validity of the Hands On Minds On-Integrated E-LKPD

The theoretical feasibility of the E-LKPD integrated with the Hands On Minds On approach for the topic of environmental change was determined through validation by three experts: a content specialist, an education expert, and a biology teacher from SMA Negeri 16 Surabaya. The validation results are presented in Table 2 and Figure 1.

Table 2. Recapitulation of E-LKPD Validation Results

No.	Assessed Aspect	Score			Average	Percentage (%)
		V1	V2	V3		
A.	**Presentation**					
1.	Quality of E-LKPD Usability or Functionality	16	16	16	16	100
2.	Quality of E-LKPD Cover Design	28	26	26	26,6	95
3.	Quality of Layout	16	15	16	15,6	97,5
4.	Quality of Presentation Media (Images, Videos, QR Codes, Hyperlinks)	23	24	24	23,66	98,6
Average of Presentation Aspects (%)						**97,8**
B.	**Content**					
5.	Completeness of E-LKPD Components	28	28	28	28	100
6.	Quality of Conceptual Content	16	16	15	15,6	97,5
7.	Completeness of Environmental Change Material	12	12	12	12	100
8.	Relevance to Everyday Life	16	16	16	16	100
9.	Alignment of Hands On Minds On with Critical Thinking Skills	24	24	23	23,6	98,3
Average of Content Aspects (%)						**99,2**
C.	**Language**					
10.	Readability	16	15	16	15,6	97,5
11.	Language Usage	16	15	16	15,6	97,5
Average of Language Aspects (%)						**97,5**
Overall Average of All Aspects (%)						**98,15**
Criteria						**Very Valid**

Keterangan:
V_1: Biology content expert ; V_2: Educational expert ; V_3: Biology teacher at SMA Negeri 16 Surabaya

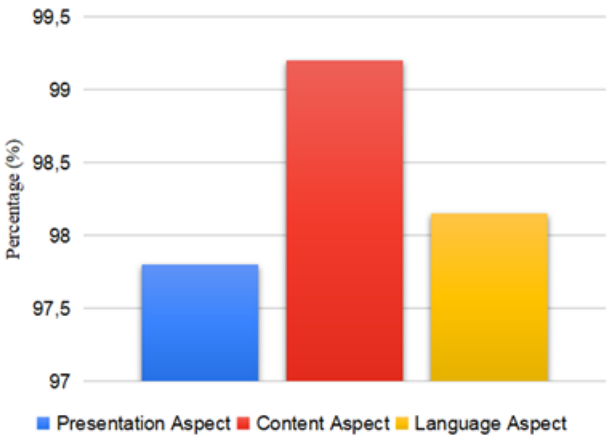


Figure 1. Diagram of E-LKPD Validation Results

Based on the validation results from three expert validators, the E-LKPD obtained an average score of 98.15%, placing it in the "Very Valid" category. This assessment covered three main aspects: presentation, content, and language. The presentation aspect received a score of 97.8%, indicating a clear and visually appealing layout with well-structured material. The content aspect achieved the highest score of 99.2%, reflecting accurate material that is relevant to the learning objectives and aligned with the Hands On Minds On approach. The language aspect received a score of 97.5%, demonstrating the use of clear, communicative language in accordance with Indonesian linguistic norms. Furthermore, the E-LKPD includes all essential components of instructional design, such as learning objectives, usage instructions, activity steps, and evaluation questions, as outlined by Yunus and Alam (2018).

These validation results are supported by previous studies, which suggest that validated instructional materials can enhance students' learning motivation and critical thinking skills (Dewi & Kurniawan, 2021). In addition, the Hands On Minds On approach applied in the E-LKPD has been shown to effectively foster active physical and cognitive engagement among students (Santosa & Pertiwi, 2023). The activities integrated within the E-LKPD are designed to cultivate critical thinking through observation, analysis, interpretation, and evaluation processes based on Facione's (2020) critical thinking indicators. Therefore, the E-LKPD meets substantive feasibility standards and is ready for classroom implementation during the trial phase.

Practicality of the Hands On Minds On Integrated E-LKPD

The practicality of the E-LKPD integrated with the Hands On Minds On approach for the environmental change topic was assessed through observations of student activities during the learning process. Four observers conducted detailed observations using systematically developed observation sheets. The practicality assessment focused on several aspects, including the extent to which the learning activities could be implemented in the classroom, any obstacles encountered during the use of the instructional media, and student feedback collected through questionnaires (Table 3).

Table 3. Recapitulation of Learning Implementation Observations

Observer (P)	Group	Total Number of Activities	Number of "Yes" Responses	Implementation Percentage	Category
P1	1	16	16	100%	WB
P1	2	16	16	100%	WB
P2	3	16	16	100%	WB
P2	4	16	16	100%	WB
P3	5	16	16	100%	WB
P3	6	16	16	100%	WB
P4	7	16	16	100%	WB

Note:
WB: Well Implemented

Based on the analysis presented in Table 3, all four observers provided consistent evaluations, indicating that all learning activities designed to foster critical thinking indicators were fully implemented, with an implementation rate reaching 100%. This achievement falls under the "Well-Implemented" category. These findings demonstrate that each stage of the learning process successfully provided opportunities for students to actively develop their critical thinking skills. For instance, environmental issue analysis activities supported the development of analytical and evaluative abilities; group discussions enhanced interpretation and explanation skills; while end-of-lesson reflections facilitated the development of self-regulation.

These outcomes suggest that the developed E-LKPD not only meets technical feasibility standards but is also effective in achieving learning objectives aimed at strengthening students' critical thinking skills in the context of environmental change. The practicality of this E-LKPD is further supported by the results of the student response questionnaire, as presented in Table 4 below:

Table 4. Results of Student Responses to the E-LKPD

No.	Assessment Item	Criteria		Percentage (%)	Category
		Yes	No		
E-LKPD Criteria					
1.	The E-LKPD cover design is attractive	34	0	100	VP
2.	The E-LKPD is easy to operate	34	0	100	VP
3.	The E-LKPD is accessible anytime and anywhere	33	0	97,1	VP
4.	Instructions in the E-LKPD are clear and easy to understand	34	0	100	VP
5.	The text in the E-LKPD is clearly readable	34	0	100	VP
6.	The provided website pages are easy to access	30	4	88,2	VP
7.	Video links can be clicked directly to access Youtube/other sources	34	0	100	VP
8.	The language used in the E-LKPD is easy to understand	34	0	100	VP
9.	The presented material is clear and easy to comprehend	34	0	100	VP
10.	The features in the E-LKPD help in understanding the learning steps	34	0	100	VP
Hands On Minds On Aspect					
11.	The introductory activity (Bio Link) stimulates observation of environmental issues	34	0	100	VP
12.	The E-LKPD helps you better understand environmental change material (Bio Concept)	34	0	100	VP
13.	The E-LKPD helps you identify problems (Bio Think)	34	0	100	VP
14.	The E-LKPD trains you to propose ideas/solutions (Bio Think)	33	1	97,1	VP
15.	The E-LKPD trains you to design experiments (Bio Activity)	34	0	100	VP
16.	The E-LKPD trains you to conduct investigations and experiments (Bio Activity)	32	2	94,1	VP
17.	The E-LKPD trains you to analyze experimental data (Bio Exercise)	34	0	100	VP

No.	Assessment Item	Criteria		Percentage (%)	Category
		Yes	No		
18.	The E-LKPD trains you to draw conclusions (Evaluation)	34	0	100	VP
Critical Thinking Skills Aspect					
19.	The E-LKPD helps train your critical thinking skills (Interpretation)	34	0	100	VP
20.	The E-LKPD helps you interpret problems in everyday contexts (Interpretation)	34	0	100	VP
21.	The E-LKPD encourages you to analyze relevant information (Analysis)	34	0	100	VP
22.	The E-LKPD helps you make inferences based on available information (Inference)	34	0	100	VP
23.	The E-LKPD facilitates evaluating solutions to problems (Evaluation)	34	0	100	VP
24.	The E-LKPD gives you opportunities to construct logical arguments or explanations (Explanation)	34	0	100	VP
25.	The E-LKPD trains you to conclude based on observation (Self Regulation)	34	0	100	VP
Average Score				**99,06**	VP

Note:
VP: Very Practical

The practicality of the E-LKPD was analyzed based on student responses after participating in learning activities using the E-LKPD integrated with the Hands On Minds On approach. Data were obtained through questionnaires completed by 34 students, as shown in Table 4. The summary results indicated an average practicality percentage of 99.06%, which falls under the "Very Practical" category. This high percentage reflects that students found the E-LKPD easy to use in various aspects, including communicative language, attractive visual design, clear instructions, and meaningful learning activities. The overwhelmingly positive responses from students indicate that the learning tool meets practical standards from the perspective of its end users.

These findings align with the view of Sari and Susantini (2023), who stated that the practicality of instructional materials is reflected in their ease of implementation by both teachers and students, as well as in their ability to achieve learning objectives without significant obstacles. Masrinah et al. (2019) further emphasized that a learning tool can be considered practical if it is easy to use in real classroom settings and receives positive feedback from users. In this context, the integration of the Hands On Minds On approach within the E-LKPD has proven effective in enhancing student engagement both physically, through hands-on activities, and cognitively, through information processing and reflection (minds-on). This is supported by Ruku (2019), who asserted that learning experiences involving both physical and mental activities can significantly improve conceptual understanding and meaningful student engagement.

Moreover, the practicality of the E-LKPD also contributes to achieving critical thinking indicators. The learning activities designed within the E-LKPD not only facilitated students in navigating the learning process but also actively engaged them in higher-order thinking processes. Thus, the findings provide evidence that the developed E-LKPD is not only feasible and optimally implemented, but also highly practical for use in enhancing the quality of both teaching and learning outcomes.

CLOSING

Conclusion

Based on the results of the development research, it can be concluded that the E-LKPD integrated with the Hands On Minds On approach for the topic of environmental change was successfully developed with a high level of validity and practicality to train students' critical thinking skills. The product was deemed very valid in terms of content, presentation, and language. Its practicality was also rated highly, as evidenced by the successful implementation of learning activities, student engagement, and positive student responses. Therefore, this E-LKPD is considered suitable for use as an innovative instructional tool that can effectively support the enhancement of students' critical thinking skills in addressing environmental issues in a contextual manner.

Suggestion

The development of instructional materials such as E-LKPD based on the Hands On Minds On approach continues to be enhanced and widely applied in biology education, particularly for topics that require critical thinking skills, such as environmental change. Teachers are encouraged to integrate this approach into daily classroom activities to foster both physical and cognitive engagement among students. More importantly, further research is needed on other biology topics with a larger

sample size to ensure that students' problem-solving abilities continue to grow as essential preparation for meeting the demands of 21st-century skills.

Acknowledgements

Gratitude is extended to Prof. Dr. Endang Susantini, M.Pd., Dr. Tarzan Purnomo, M.Si., and Rufi'ah, S.Pd., M.Pd. for serving as examiners and validators, as well as to the students of class X-10 at SMA Negeri 16 Surabaya who participated as research subjects in the 2024/2025 academic year.

REFERENCES

Agnafia, D. N. 2019. Analisis Kemampuan Berpikir Kritis Siswa dalam Pembelajaran Biologi. Florea. *Jurnal Biologi dan Pembelajarannya*. 6(1), 45-53.

Dewi, R., & Kurniawan, D. A. 2021. Validasi Perangkat Pembelajaran Berbasis Literasi Sains untuk Siswa SMA. *Jurnal Pendidikan Sains Indonesia*. 9(1), 1–10.

Facione, P. A., Facione, N. C., & Gittens, C. A. 2020. What The Data Tell Us About Human Reasoning In Critical Thinking and Reasoning. Brill. 272-297.

Indarta, Y., Ambiyar, A., Samala, A. D., & Watrianthos, R. 2022. Metaverse: Tantangan dan Peluang dalam Pendidikan. *Jurnal Basicedu.* 6(3), 3351–3363.

Masrinah, E. N., Ipin, A., dan Aden, A. G. 2019. Problem Based Learning (PBL) untuk Meningkatkan Keterampilan Berpikir Kritis. *Jurnal Education*. 1(1). 924-932.

Nisa, W. Z., & Fitrihidajati, H. 2024. Pengembangan Lembar Kegiatan Peserta Didik Elektronik Berbasis *Problem Based Learning* pada Sub Materi Pencemaran Lingkungan untuk Melatihkan Keterampilan Berpikir Kritis. *Berkala Ilmiah Pendidikan Biologi (BioEdu)*. 13(1), 30-38.

Permendikbud. 2016. Peraturan Mentri Pendidikan dan Kebudayaan Nomor 22 Tahun 2016 tentang Standar Proses Pendidikan Dasar dan Menengah.

Rahmadani, N., & Anugraheni, I. 2017. Peningkatan Aktivitas Belajar Matematika Melalui Pendekatan *Problem Based Learning* Bagi Siswa Kelas 4 SD. Scholaria: *Jurnal Pendidikan dan Kebudayaan*. 7(3), 241-250.

Ramdani, D., & Badriah, L. 2018. Korelasi Antara Kemampuan Berpikir Kritis dengan Hasil Belajar Siswa melalui Model Pembelajaran Inkuiri Terbimbing Berbasis *Blended Learning* pada Materi Sistem Respirasi Manusia. *Bio Education*. 3(2).

Riduwan. 2016. *Skala Pengukuran Variabel-Variabel Penelitian*. Bandung: Alfabeta.

Ruku, E. C. & Purnomo., T. 2019. Validitas Lembar Kegiatan Siswa pada Materi Perubahan Lingkungan untuk Melatihkan Kemampuan Berpikir Kritis. *Jurnal Bioedu*. 8(3). 1-8.

Santosa, I. G. B., & Pertiwi, I. G. A. D. 2023. The Effectiveness of Hands-On Minds-On Approach In Science Learning: A Review of Recent Studies. *International Journal of Education and Learning*. 5(1), 30–42.

Sari, A. H. I., & Susantini, E. 2023. Pengembangan E-LKPD Berbasis Saintifik pada Materi Perubahan Lingkungan untuk Melatihkan Keterampilan Berpikir Kritis Peserta Didik. *Berkala Ilmiah Pendidikan Biologi (BioEdu)*. 12(3), 673-682.

Syamsi, A. N., & Fitrihidajati, H. 2021. Validitas Lembar Kegiatan Peserta Didik (LKPD) Berbasis *Problem Based Learning* (PBL) pada Materi Perubahan Lingkungan untuk Melatihkan Keterampilan Berpikir Kritis Siswa Kelas X SMA. *Berkala Ilmiah Pendidikan Biologi (BioEdu)*. 10(2), 397-402.

UNESCO. 2020. *Education for Sustainable Development: A Roadmap*. Paris: UNESCO. Diakses dari: https://unesdoc.unesco.org/ark:/48223/pf0000374802 .

Yannier, N., Hudson, S. E., Koedinger, K. R., Hirsh-Pasek, K., Golinkoff, R. M., Munakata, Y., dan Brownell, S. E. 2021. Active Learning:"Hands-On" Meets "Minds-On". *Science.* 374(6563), 26-30.

Yunus, Y., & Alam, S. 2018. Pengembangan LKPD Berbasis Literasi Sains untuk Meningkatkan Keterampilan Proses Sains Siswa. *Jurnal Pendidikan.* 19(2), 101–110.