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Validation of the Physics E-Module Based on Problem Based Learning as Independent Teaching Material to Improve Critical Thinking Skills of Class XI High School Students

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Abstract: Students' critical thinking skills are very useful and useful as preparations for facing current and future life, but the reality in the field is that students' critical thinking skills are still low. So one solution is to develop e-modules based on problem based learning. This research aims to determine the level of validity of problem based learning-based e-modules as independent teaching materials to improve the critical thinking skills of class XI high school students. The development model used is ADDIE. The instrument used in this research was a validation questionnaire by 3 validators. The data analysis technique used is the Aiken'V formula. The e-module validation results obtained an average of 0.93 with a valid category. So it can be concluded that the physics e-module based on problem based learning to improve students' critical thinking skills is valid and suitable for use in learning at school.

Keywords: Critical thinking skills; E-module; Problem based learning

Introduction

The implementation of an independent curriculum in schools gives teachers the freedom to create quality learning according to the needs of students and their environment. The independent curriculum is a curriculum with diverse intracurricular learning whose content is more optimal and teachers have the flexibility to choose various teaching tools to adapt teaching to students' learning needs and interests. The characteristics of an independent curriculum consist of developing students' soft skills and character, focusing on essential material and flexible learning (Khoirurrijal et al., 2022).

21st century skills are one of the most important skills that students must master to face future challenges (Asrizal et al., 2023). Chalkiadaki (2018) also said that 21st century skills are important for students with the goal of academic and life success in the future. In the 21st century teachers must carry out the teaching and learning process in accordance with the demands of 21st century learning (Sumardi et al., 2020). The 21st century is called the era of globalization which is marked by the very rapid development of science and technology and has become an indispensable need for humans. The 21st century requires every individual to combine technological sophistication with human resources (HR) functions to produce skilled human resources (Memori et al., 2020). Rasmi et al. (2023) also stated that nowadays, the world of education is greatly influenced by developments in science and technology. Human life cannot be separated from science and technology, technological progress will run according to the times.

21st century skills known as 6C, namely critical thinking, creativity, collaboration and communication, character, citizenship (Afif et al., 2021). The ability to think critically, think creatively and solve problems, communicate and collaborate, create and update, contextual learning, as well as information and media literacy skills are one of the 21st century skills

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emphasized in the curriculum (Zan et al., 2023). One of the 21st century skills is critical thinking skills. Critical thinking is the process of using rational and reflective thinking skills aimed at making decisions about what to believe or do (Purwoko et al., 2023). A person must have the ability to think critically and needs to learn it, because this skill is very useful and useful as a preparation for facing life now and in the future (Zaskia & Lestari, 2019). Physics learning is one method to foster students' critical thinking skills as well as the process of various elements and activities carried out to examine various natural events (Nisak & Yulkifli, 2021).

Based on the explanation above, it can be seen that the importance of students' critical thinking skills. However, the real conditions in the field do not match the expected conditions. This is proven by the results of initial observations in the field where the implementation of the independent curriculum in accordance with the characteristics of the independent curriculum has not been fully achieved and students' critical thinking skills are still relatively low. Based on these problems, a solution is needed to overcome these problems. One solution to overcome the problems above is to develop electronic teaching materials such as e-modules based on problem based learning.

E-modules are digital or non-printed teaching materials that are arranged systematically according to a certain curriculum and packaged in a certain time unit format and presented on electronic devices such as computers or Androids, where the contents of the e-module learning materials are materials, methods, limitations and how to assess the achievement of expected competencies electronically according to the level of complexity, and e-modules can be used as independent teaching materials (Priatna et al., 2017). The advantages of e-modules compared to printed modules are that they are interactive, make navigation easier, display images, sound, video and animation, and are equipped with formative tests/quizzes (Sugihartini & Jayanta, 2017).

One model that is suitable to be applied to e-modules that can improve critical thinking skills is the problem based learning model. Problem Based Learning (PBL) is learning that uses problems as a context for students to learn about critical thinking, problem solving skills, gaining important knowledge and concepts from subject matter (Susilawati & Supriyatno, 2023). According to Abed et al. (2023) PBL is a process where students are given a problem or trigger in the form of a video, image, statement, or case, and allow them to work together to solve it. So the aim of this research is to determine the level of validity of the physics e-module based on problem based learning as independent teaching material to improve the critical thinking skills of class XI high school students.

Method

This research is development research by producing a product in the form of a physics e-module based on problem based learning as independent teaching material to improve the critical thinking skills of class XI high school students on the material Dynamics of Particle Motion. The development model used in this research is the ADDIE model. The ADDIE model consists of 5 stages, namely analysis, design, development, implementation, evaluation (Rusdi, 2018).

The instrument used in this research was a validation questionnaire. The validation questionnaire distributed to validators consists of 4 aspects, namely material substance, learning design, appearance and use of software. The validators used were 3 physics education lecturers at Padang State University.

Product assessments based on questionnaires filled out by experts are analyzed to determine the level of validity of the product being developed. Validity analysis uses a Likert scale with the following steps: first, scoring for each answer item with the answer items being Strongly Agree (5), Agree (4), Undecided (3), Less Agree (2), and Disagree (1); second, adding up the total score of each validator for all indicators; third, Determining validity using the Aiken's V formula, namely:

$$V = \frac{\sum s}{[n(c-1)]} \quad (1)$$

Information:
S : $r - l_0$
l_0 : Lowest validity assessment number (in this case = 1)
c : Highest validity assessment number(in this case = 5)
r : Numbers provided by validators
n : Number of assessments

Validity categories based on the Aiken's V coefficient can be seen in Table 1.

Table 1. Product Validity Categories (Azwar, 2015)

Intervals	Category
≥ 0.6	Valid
< 0.6	Invalid

Result and Discussion

The development model used in this research is the ADDIE model consisting of analysis, design, development, implementation and evaluation. The analysis stage is the first step in the ADDIE model which is carried out to look at problems in the field. Next is the

design stage, where the researcher designs the product being developed, namely a physics e-module based on problem based learning to improve students' critical thinking skills. After the product is designed, it continues to the development stage which aims to produce teaching materials in the form of physics e-modules. This development consists of activities to create, provide and modify e-modules to achieve predetermined goals. The e-module framework developed according to the Kemendikbud (2017) consists of a cover, foreword, table of contents, glossary, introduction, learning activities, evaluation, answer key, and bibliography, and in the e-module developed there is also an author profile. After that, the resulting e-module is validated by expert lecturers. The following is a picture of the e-module being developed.

Figure 1. E-Module cover

The cover of the e-module contains the UNP logo, education logo, e-module title, topic/learning material, education level, class, semester, author's name, images related to the material, study program, university name, and year. The e-model cover is designed to be as attractive as possible so that readers are interested in reading the e-module being developed. Furthermore, the introduction to the e-module contains instructions for using the e-module, learning outcomes and learning materials. The following is an image of the e-module introduction.

There are four learning activities in the E-Module, each learning activity consists of several parts, namely learning objectives, worksheets, material descriptions, summaries, exercises and self-assessment. Apart from that, in learning activities there are also problem based learning models and critical thinking indicators. Problem-based learning (PBL) is a collaborative, student-centered learning approach that relies on student involvement in stimulating real-life situations (problems) (Saqr et al., 2023). According to Sofyan et al. (2017) the syntax of the problem based learning model consists of five phases, namely: first, student orientation to the problem. Second, organizing students to study. Third, guide individual and group investigations. Four, Develop and present results. Five, analyze and evaluate the process and results of problem solving.

Critical thinking is the ability to think at a complex level and use processes of analysis and evaluation. Critical thinking involves inductive thinking skills such as identifying relationships, analyzing open problems (many possible solutions), determining cause and effect, drawing conclusions and calculating meaningful information (Rachmantika et al., 2019).

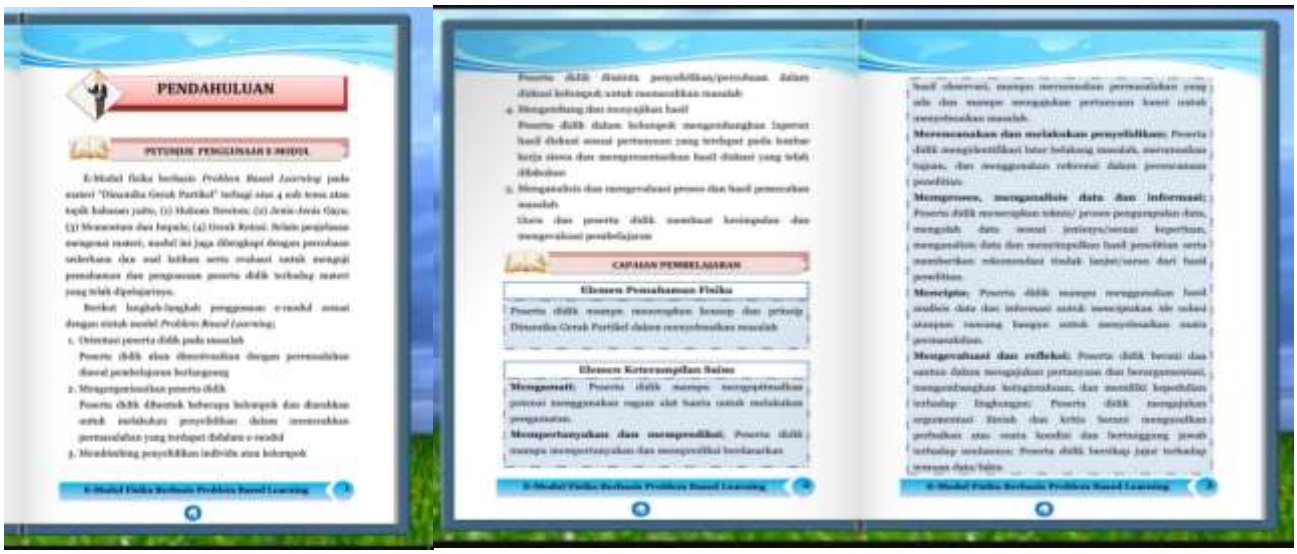

Figure 2. Introduction

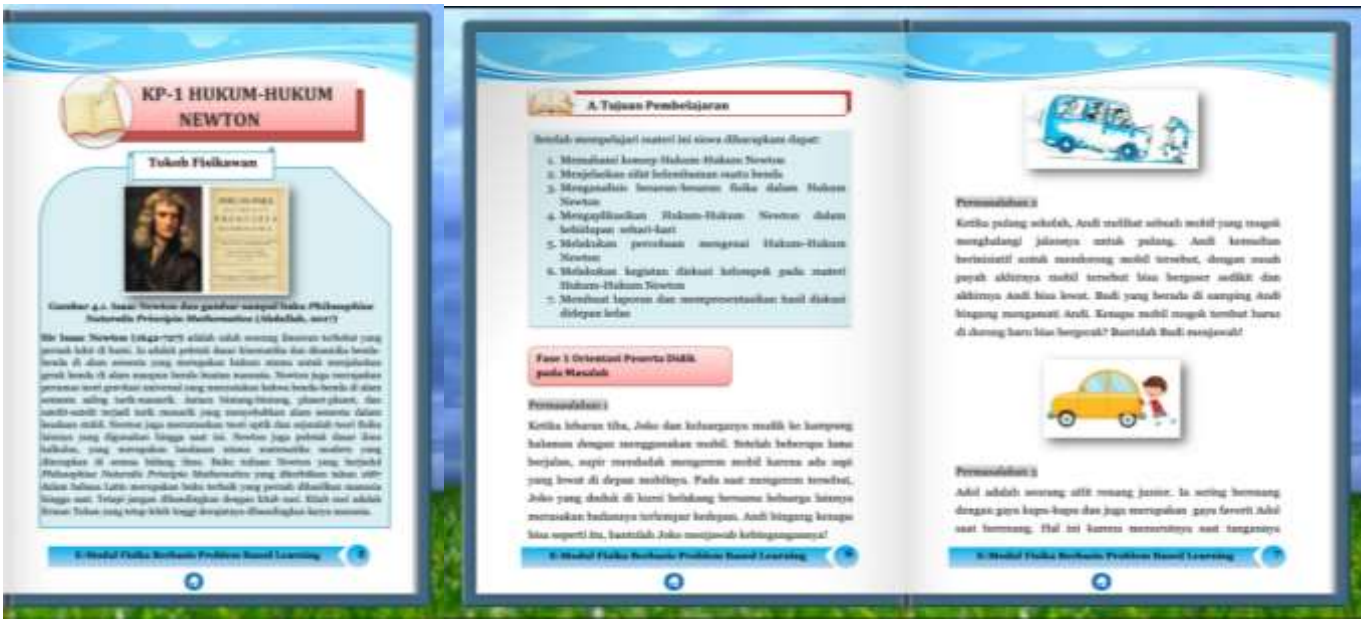

Figure 3. Learning activities

Indicators of critical thinking according to Ennis (2011) are providing simple explanations, building basic skills, drawing conclusions, providing further explanations, and organizing strategies and tactics. Meanwhile, indicators of critical thinking according to Facione (2011) are interpretation, analysis, evaluation, inference, explanation and self-regulation. So from these two experts, the indicators of critical thinking contained in the e-module are interpretation, analysis, evaluation, inference and explanation.

Instrument Validation

The instrument for validating the product in the form of a physics e-module based on problem based learning to improve students' critical thinking skills was validated first by 3 validators, namely physics education lecturers at Padang State University using a validation instrument assessment sheet, in order to see whether the validation assessment instrument used to validate The e-module is able to measure the validation of the e-module or not. The validation instrument assessment sheet includes several indicators, namely the validation instrument produced in accordance with the objectives to be achieved. The instrument meets the assessment performance criteria, including: clarity regarding instructions for using the instrument, ease of use of the instrument, accuracy of component assessment items, and clarity of feedback. And the instrument meets appearance criteria such as: instrument readability and instrument display quality.

The results obtained from the validation instrument assessment were 0.97 with a valid category because the average assessment of the e-module validation instrument was greater than 0.6. So the physics e-module validation instrument based on problem based learning to improve students' critical thinking skills can be used to validate the e-module.

Validation of the Physics E-Module Based on Problem Based Learning to Improve Critical Thinking Skills

E-Module physics based on problem based learning to improve students' critical thinking skills was validated by 3 experts, namely physics education lecturers at Padang State University. The validation assessment aspects are the substance of the material, learning design, appearance and use of software. In the material substance aspect, there are four indicators, namely truth, depth, currentness and readability. The learning design aspect consists of twelve indicators, namely title, learning outcomes, learning objectives, materials, sample questions, exercises, student worksheets, summaries, self-assessment, evaluation, organizers and references. The display aspect consists of five indicators, namely navigation, letters, media, color and layout. Then the software utilization aspect consists of three indicators, namely interactive, software, and authenticity. The validation results of the three experts can be seen in Table 2.

Table 2. E-Module Validity Results

Aspect	Average	Category
Material Substance	0.92	Valid
Learning Design	0.92	Valid
Display	0.93	Valid
Utilization of Software	0.94	Valid
Average	0.93	Valid

Based on the table above, the material substance aspect obtained an average validation value of 0.92 with

the valid category, the learning design aspect obtained an average validation value of 0.92 with the valid category, the appearance aspect obtained an average validation value of 0.93 with the valid category, and in the software utilization aspect, an average validation value of 0.94 was obtained in the valid category. Then the average validation value of the four aspects is 0.93 with the valid category. The problem based learning e-module developed is in accordance with the specified objectives, namely to improve thinking skills. In the e-module, the syntax of the problem based learning model is clearly described. Then critical thinking indicators such as interpretation, analysis, evaluation, inference and explanation have also been clearly depicted in the e-module being developed.

The e-module developed utilizes technology in line with current developments. E-Modules are easily accessed by students because they can be opened via cellphone. So students can use the e-module anywhere without being limited by place and time. Then, in terms of appearance, the e-module is contrasting and can attract students to learn using the e-module. So that the physics e-module based on problem based learning as an independent teaching material to improve the critical thinking skills of class XI high school students is suitable for use in learning at school.

Good teaching materials can facilitate students to get to know the natural surroundings better (Cebesoy & Öztekin, 2017; Hancock et al., 2019; Brunner & Abd-El-Khalick, 2020; Chen & Xiao, 2021). Therefore, the presentation of material is said to be good if the teaching materials used are valid and suitable for use. This is in accordance with research by Wati et al. (2023) which states that the E-module based on an inquiry model that is integrated with the SETS approach is suitable for use as teaching material for mechanical waves, traveling waves and stationary waves in mechanical waves subjects for class XI MIPA SMA. Another relevant research by Kurniawan et al. (2021) states that Guided Inquiry-based e-modules integrated with Ethnoscience can improve students' critical thinking skills that are valid and can be used by students. Research by Syuzita et al. (2023) states that the Argument-Driven Inquiry based E-Module uses 3D Pageflip Professional which was developed and meets the very valid criteria.

Conclusion

Based on the results of the research conducted by the researcher, it can be concluded that the physics E-Module based on problem based learning to improve students' critical thinking skills has valid criteria in terms of material substance, learning design, appearance and use of software with an average validation result of 0, 93. This can be interpreted as a physics e-module based on problem based learning to improve students' critical thinking skills is valid and suitable for use in learning at school.

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Author Contributions

Author contributions include Riza Azriyanti: collecting data, analyzing data, writing original draft, and so on; Syafriani: person in charge of research.

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Conflicts of Interest

The authors declare no conflict of interest.

References

Abed, S. S., Al-Mansour, M., Ahmed, S. N., Khan, M. A., Martin, P. N., Shah, S. W., & Aga, S. S. (2023). Evaluation of Problem-Based Learning in College of Medicine: An Indicator of Quality Education in a Hybrid Curriculum. *Education Research International*, *2023*, 1–9. https://doi.org/10.1155/2023/9955409

Afif, K., Sunismi, S., & Alifiani, A. (2021). Pengembangan Bahan Ajar Interaktif Bermuatan 6C (Critical Thinking, Creative Thinking, Collaboration, Communication, Character, dan Citizenship) pada Materi Pola Bilangan Kelas VIII. *Jp3*, *16*(1), 284–293. Retrieved from http://www.riset.unisma.ac.id/index.php/jp3/article/view/9830

Asrizal, A., Usmeldi, U., & Azriyanti, R. (2023). Meta-Analysis of the Influence of the STEM-Integrated Learning Model on Science Learning on 21st Century Skills. *Jurnal Penelitian Pendidikan IPA*, *9*(8), 339–347. https://doi.org/10.29303/jppipa.v9i8.3094

Azwar, S. (2015). *Reliabilitas dan Validitas*. Yogyakarta: Pustaka Pelajar. Retrieved from https://pustakapelajar.co.id/buku/reliabilitas-dan-validitas/

Brunner, J. L., Abd-El-Khalick, F. (2020). Improving Nature of Science Instruction in Elementary Classrooms with Modified Trade Books and Educative Curriculum Materials. In: McComas, W.F. (eds) *Nature of Science in Science Instruction. Science: Philosophy, History and Education*. Springer, Cham. https://doi.org/10.1007/978-3-030-57239-6_25

Cebesoy, U. B., & Öztekin, C. (2017). Genetics Literacy: Insights from Science Teachers' Knowledge, Attitude, and Teaching Perceptions. *International Journal of Science and Mathematics Education, 16*(2). https://doi.org/10.1007/s10763-017-9840-4

Chalkiadaki, A. (2018). A Systematic Literature Review of 21st Century Skills and Competencies in Primary Education. *International Journal of Instruction*, 11(3), 1–16. Retrieved from https://files.eric.ed.gov/fulltext/EJ1183407.pdf

Chen, L., & Xiao, S. (2021). Perceptions, Challenges, and Coping Strategies of Science Teachers in Teaching Socioscientific Issues: A Systematic Review. *Educational Research Review, 32*. https://doi.org/10.1016/j.edurev.2020.100377

Ennis, R. H. (2011). *The Nature of Critical Thinking: An Outline of Critical Thinking Dispositions and Abilities*. Chicago: University of Illinois. Retrieved from https://education.illinois.edu/docs/default-source/faculty-documents/robert-ennis/thenatureofcriticalthinking_51711_000.pdf

Facione, P. A. (2011). *Critical Thinking: What It Is and Why It Counts*. Insight Assessment, (ISBN 13: 978-1-891557-07-1.), 1–28. https://doi.org/ISBN 13: 978-1-891557-07-1

Hancock, T. S., Friedrichsen, P., Kinslow, A. T., Sadler, T. D. (2019). Selecting Socio-scientific Issues for Teaching: A Grounded Theory Study of How Science Teachers Collaboratively Design SSI-Based Curricula. *Science & Education, 28*(4). https://doi.org/10.1007/s11191-019-00065-x

Kemendikbud. (2017). *Panduan Praktis Penyusunan E-Modul.* Jakarata: Direktorat Pembinaan SMA. Ditjen Pendidikan Dasar dan Menengah. Retrieved from https://awan965.files.wordpress.com/2017/09/panduan_penyusunan-e-modul-2017_final_edit.pdf

Khoirurrijal, K., Fadriati, F., Sofia, S., Makrufi, A. D., Gandi, S., Muin, A., Tajeri, T., Fakhrudin, A., Hamdani, H., & Suprapno, S. (2022). *Pengembangan Kurikulum Merdeka.* Malang: CV. Literasi Nusantara Abadi.

Kurniawan, R., & Syafriani, S. (2021). The Validity of E-Module Based on Guided Inquiry Integrated Ethnoscience in High School Physics Learning to Improve Students' Critical Thinking. *Journal of Physics: Conference Series*, *1876*(1). https://doi.org/10.1088/1742-6596/1876/1/012067

Memori, E. O., Darvina, Y., Syafriani, S., & Dewi, W. S. (2020). Validasi LKS Berbasis Problem Solving dalam Meningkatkan Keterampilan 4C pada Materi Termodinamika dan Gelombang Mekanika. *Pillar of Physics Education*, *13*(2), 257–264. Retrieved from https://ejournal.unp.ac.id/students/index.php/pfis/article/view/7946/3937

Nisak, F., & Yulkifli, Y. (2021). Development of Electronic Module Using Inquiry Based Learning (IBL) Model Integrated High Order Thinking Skill (HOTS) in 21st Century Physics Learning Class X. *Journal of Physics: Conference Series*, *1876*(1), 1–9. https://doi.org/10.1088/1742-6596/1876/1/012085

Priatna, I. K., Putrama, I. M., & Divayana, D. G. H. (2017). Pengaruh E-Modul Berbasis Model Pembelajaran Project Based Learning pada Mata Pelajaran Videografi untuk Siswa Kelas X Desain Komunikasi Visual SMK Negeri 1 Sukasada. *Jurnal Nasional Pendidikan Teknik Informatika (JANAPATI)*, *6*(1), 70–78. https://doi.org/10.23887/janapati.v7i3.13433

Purwoko, R. Y., Kusumaningrum, B., Laila, A. N., & Astuti, E. P. (2023). Development of Open Ended Based Mathematics E-Modules to Enhance Students' Critical Thinking Ability. *Mathline: Jurnal Matematika dan Pendidikan Matematika*, *8*(1), 194–206. https://doi.org/10.31943/mathline.v8i1.337

Rachmantika, A. R., & Wardono, W. (2019). Peran Kemampuan Berpikir Kritis Siswa pada Pembelajaran Matematika dengan Pemecahan Masalah. *Prosiding Seminar Nasional Matematika*, *2*(1), 441. Retrieved from https://journal.unnes.ac.id/sju/index.php/prisma/article/view/29029/12759

Rasmi, D. P., Hendri, M., & Azriyanti, R. (2023). Analysis of the Need for Development of Teaching Materials in the Form of STEM-Based Electronic Modules. *Jurnal Penelitian Pendidikan IPA*, *9*(6), 4135–4141. https://doi.org/10.29303/jppipa.v9i6.2683

Rusdi, R. (2018). *Penelitian Desain dan Pengembangan Kependidikan (Konsep, Prosedur, dan Sintesis Pengetahuan Baru)*. Depok: PT Raja Grafindo Persada. Retrieved from https://opac.perpusnas.go.id/DetailOpac.aspx?id=1170658

Saqr, M., & López-Pernas, S. (2023). The Temporal Dynamics of Online Problem-Based Learning:

Why and When Sequence Matters. *International Journal of Computer-Supported Collaborative Learning*, *18*, 11–37. https://doi.org/10.1007/s11412-023-09385-1

Sofyan, H., Wagiran, W., Komariah, K., & Triwayono, T. (2017). P*roblem Based Learning dalam Kurikulum 2013*. Yogyakarta: UNY Pres.

Sugihartini, N., & Jayanta, N. L. (2017). Pengembangan E-Modul Mata Kuliah Strategi Pembelajaran. *Jurnal Pendidikan Teknologi dan Kejuruan*, *14*(2), 221–230. https://doi.org/10.23887/jptk-undiksha.v14i2.11830

Sumardi, L., Rohman, A., & Wahyudiati, D. (2020). Does the Teaching and Learning Process in Primary Schools Correspond to the Characteristics of the 21st Century Learning?. *International Journal of Instruction, 13*(3), 357–70. https://doi.org/10.29333/iji.2020.13325a.

Susilawati, S., & Supriyatno, T. (2023). Problem-Based Learning Model in Improving Critical Thinking Ability of Elementary School Students. *Advances in Mobile Learning Educational Research*, *3*(1), 638–647. https://doi.org/10.25082/amler.2023.01.013

Syuzita, A., Susilawati, S., & Sukarso, A. (2023). Validation of E-Module Based on Argument-Driven Inquiry using 3D Page Flip Professional to Improve Students' Generic Science, Critical Thinking and Scientific Argumentation Abilities. *Jurnal Penelitian Pendidikan IPA*, *9*(8), 6272–6277. https://doi.org/10.29303/jppipa.v9i8.4947

Wati, W. W., & Syafriani, S. (2023). Validity of Physics E-Modules Based on an Inquiry Model Integrated with the Science, Environment, Technology, and Society Approach to 21st Century Skills. *Jurnal IPA & Pembelajaran IPA*, *7*(2), 133–144. https://doi.org/10.24815/jipi.v7i2.30002

Zan, A. M., Nilyani, K., Azriyanti, R., Asrizal, A., & Festiyed, F. (2023). Effect of STEM-Based Mathematics and Natural Science Teaching Materials on Students' Critical and Creative Thinking Skills: A Meta-Analysis. *Jurnal Penelitian Pendidikan IPA*, *9*(6), 54–64. https://doi.org/10.29303/jppipa.v9i6.2678

Zaskia, L., & Lestari, I. (2019). *Berfikir Kritis dalam Konteks Pembelajaran*. Jakarta: Erzatama Karya Abadi.