Journal of Educational Research and Evaluation
Volume 8, Issue 4, 2024, pp. 622-632
P-ISSN: 2597-422x E-ISSN: 2549-2675
Open Access: https://doi.org/10.23887/jere.v8i4.78567

Problem Based Learning-Oriented E-Module to Innovate Learning Activities in High School

Aladin[1]*, Asrowi[2], Eka Budhi Santosa[3]

[1,2,3] Postgraduate of Educational Technology, Sebelas Maret University, Surakarta, Indonesia

ARTICLE INFO

Article history:
Received May 17, 2024
Accepted October 10, 2024
Available online November 25, 2024

Kata Kunci :
Modul, HOTS, Problem Based-Learning, Informatika, SMA

Keywords:
E-Module, HOTS, Problem Based-Learning, Informatics, High School

ABSTRAK

Dalam era digital yang terus berkembang, bahan ajar digital dalam format e-modul menjadi alternatif yang menjanjikan dalam meningkatkan efektivitas pembelajaran, terutama di sekolah menengah atas. Ditambah lagi, e-modul sebagai suatu bahan ajar bisa diintegrasikan dengan berbgaia macam pendekatan maupun model pembelajaran inovatif seperti misalnya, pembelajaran berbasis masalah. Oleh karena itu, pada riset ini bertujuan untuk mengembangkan e-modul inovatif berbasis masalah untuk pembelajaran informatika yang layak digunakan sebagi media pembelajaran. Metode penelitian yang digunakan adalah penelitian dan pengembangan dengan mengadopsi model ADDIE. Subjek penelitian meliputi ahli media, ahli materi, ahli desain pembelajaran, dan siswa. Pengumpulan data dilakukan melalui kuisioner kelayakan media, dengan teknik analisis data menggunakan deskriptif persentase. Hasil penelitian menunjukkan bahwa e-modul yang dikembangkan mendapat penilaian "Sangat Baik" dari para ahli, dengan rata-rata keseluruhan mencapai 83%. Dengan demikian, e-modul ini layak digunakan sebagai bahan ajar digital dalam pembelajaran informatika. Kesimpulannya, bahan ajar digital dalam format e-modul memiliki potensi besar sebagai media pembelajaran yang efektif untuk mata pelajaran informatika serta dinilai mampu memberikan stimulus untuk meningkatkan keterampilan HOTS bagi siswa sekolah menengah atas.

ABSTRACT

In the continuously evolving digital era, digital teaching materials in the form of e-modules have emerged as a promising alternative to enhance the effectiveness of learning, particularly in high schools. Furthermore, e-modules as instructional materials can be integrated with various innovative approaches and models of learning, such as problem-based learning. Therefore, this research aims to develop an innovative problem-based e-module for computer science education that is deemed suitable as a learning medium. The research method employed is research and development, adopting the ADDIE model. The research subjects include media experts, subject matter experts, instructional design experts, and students. Data collection is conducted through a media feasibility questionnaire, The data collection instrument uses a feasibility questionnaire for each expert, practitioner and student. As for data analysis was using descriptive percentages. The research findings indicate that the developed e-module received a "Very Good" rating from the experts, with an overall average score of 83%. Thus, this e-module is deemed suitable as a digital teaching material for computer science education. In conclusion, digital teaching materials in the form of e-modules have significant potential as effective learning media for computer science subjects and are considered capable of providing stimuli to enhance higher-order thinking skills for high school students. This e-Module can be an innovation in facilitating computer science learning for high school students.

1. INTRODUCTION

In the early 20th century, education was primarily focused on mastering basic skills such as reading, writing, and arithmetic (Pamungkas et al., 2020; Malik, 2018). However, very few educational institutions emphasized deeper learning, such as critical reading and writing. It was only in the 21st century that the government adopted a paradigm shift in education towards the mastery of soft skills, including critical thinking and problem-solving, which are considered higher-order thinking skills (Novitras et al.,

*Corresponding author.
E-mail addresses: aladintp@student.uns.ac.id (Aladin)

2021; Iqbal et al., 2023). The emergence of high-order thinking skills issues has resonated significantly in the field of education, especially during the national exams a few years ago. Exam questions based on HOTS initially raised concerns among teachers as students often were not prepared to face such level of difficulty (Tyan et al., 2020; Fauzi & Basikin, 2020). High-order thinking skills are considered as one of the life skills that should be developed in schools (Masnur et al., 2019; Silalahi et al., 2022), as they can serve as the foundation for students' knowledge and skills towards a more responsible direction.

Several relevant theories and research finding already suggested that higher-order thinking skills (HOTS) encompass logical reasoning, critical thinking skills, analytical skills, evaluative skills, creative thinking, problem-solving, and decision-making (Maryani et al., 2021; Luciana, 2020). Higher-order thinking skills require a deeper understanding of knowledge, not just memorization, but also connecting existing information to perform analysis and generate new ideas (Ketut Sri Puji Wahyuni et al., 2021; Suanto et al., 2020). HOTS can be considered as complex thinking skills that involve activities such as deconstructing material, analyzing, and finding solutions as a form of problem-solving. Therefore, mastery of higher-order thinking skills is crucial for learners to face the rapid development of time and the rapid flow of information. Based on observations at Batik Surakarta High School 1, students show several shortcomings in their learning activities. Firstly, they sometimes struggle to express their understanding of the taught material. Secondly, even though they are given the opportunity to ask questions, students rarely do so, and when they do, their responses tend to be brief. Thirdly, students often face difficulties in solving problems when working on tasks that are considered difficult. This condition leads to the students' inactivity in the learning process, as well as their low ability in critical thinking or higher-order thinking, which in turn hinders their ability to solve problems. Additionally, interviews with the computer science teacher at SMA 1 Batik Surakarta indicate that the development of learning media at the school has not been adequately done to support high-level thinking skills-based learning. The available modules are still in print form with simple designs and content. The learning process also tends to be more teacher-centered, which is not in line with the expected high-level thinking learning approach.

Problem Based Learning (PBL) is considered to have the potential to facilitate the development of students' higher-order thinking skills. PBL is a learning approach that places students at the center, with a focus on collaboration and problem-solving relevant to the context. This approach demands students to acquire a deeper understanding of the subject matter, as the learning process begins with the identification of concrete problems that are then connected to the concepts in the curriculum (Permatasari et al., 2019; Rahman et al., 2018). In PBL, students are given the opportunity to discover problems in their surroundings that can be the focus of their learning. The implementation of the PBL model involves not only analysis but also the collection, synthesis, and presentation of information (Simanjuntak et al., 2021; Nurtanto et al., 2019). Therefore, learning becomes more meaningful when students are actively engaged, and educators are challenged to be more creative in using teaching models that can stimulate student participation.

Problem Based Learning (PBL) has been proven to enhance students' learning motivation and deepen their understanding and achievement (Fitriani et al., 2021; Nurhayati et al. 2021). This learner-centered approach has also been shown to improve critical thinking skills, problem-solving abilities, creativity, and self-directed learning, as well as foster responsibility in learning. Therefore, the development of e-modules that integrate the PBL approach is expected to provide more contextual learning and enable students to apply acquired information in real-world contexts, creating new learning experiences. As a self-directed digital learning resource, well-developed and systematic e-modules are also considered a suitable solution in line with the current era, allowing students to better comprehend complex concepts. In line with the previous research, stated that e-modules have been found to significantly improve students' learning outcomes, and students feel more enthusiastic about learning when using e-modules at home (Maharani Zan & Mardian, 2022; Aufa et al., 2021). This is especially true if the e-modules are integrated with 21st-century skills. Critical thinking and problem-solving skills are among the 21st-century skills that students need to achieve (Trevallion & Nischang, 2021; Notanubun, 2019).

Schools should be able to accommodate students' needs to acquire HOTS thinking skills through the learning process. This is necessary so that students improve their thinking abilities. The development of Higher-Order Thinking Skills (HOTS) is essential for students as it surpasses basic knowledge recall, allowing them to engage in complex thinking processes like evaluation and problem-solving. Research has indicated that integrating HOTS into education can enhance academic performance (Tam, 2018; Mursyid & Kurniawati, 2019). E-Modules have been designed to promote the enhancement of students' HOTS, with studies demonstrating that their use can boost critical thinking skills and decrease misconceptions across various subjects (Permana & Syahruzah, 2023; Mursyid & Kurniawati, 2019). By integrating HOTS into educational materials such as electronic modules, students can be motivated to think broadly, confront new challenges, and deepen their comprehension (Arafah et al., 2021; Harianto & I Gde Wawan Sudatha, 2024). Moreover, the importance of critical thinking skills, a key aspect of HOTS, has resulted in its inclusion in

national curricula to equip students for the demands of the 21st century (Arican & Mutlu, 2023; Yong & Saad, 2023). Therefore, the presence of E-Modules aimed at fostering HOTS is crucial in nurturing students' critical thinking, problem-solving, and decision-making skills, ultimately enhancing their overall cognitive abilities and academic performance. Therefore, it can be concluded that the ability of Higher Order Thinking Skills (HOTS) is a future competency that needs to be trained in students. This is because the ability of HOTS cannot be instantly mastered by students, but it requires time and a long learning process to improve their skills.

One way to improve the quality of learning is by using teaching materials that encourage students to actively solve everyday problems by applying the concepts they have learned. An alternative solution to enhance the learning process is through the innovation of developing E-learning modules. E-Modules are digital teaching materials that allow students to learn independently without direct guidance from educators (Hadianto & Festiyed, 2020; Yoda et al., 2024). Through these e-modules, students will be given the opportunity to identify problems around them that can be the focus of learning. By implementing Problem-Based Learning (PBL) model, students not only analyze but also gather, synthesize information, and present their findings (Aufa et al., 2021; Abdulah et al., 2021). With active student involvement in learning, it is hoped that they can find solutions, draw their own conclusions, and be able to solve problems in their surrounding environment. Previous research findings have indicated that the utilization of digital learning modules using a problem-based learning (PBL) approach in the context of Computer Science subjects in high schools has proven to be effective in engaging students' interest during the learning process (Ismail et al., 2018; Ran & Jinglu, 2020). Furthermore, these digital learning modules, also known as e-modules, have been shown to enhance students' understanding of the learning material (Johan et al., 2022; Susantini et al., 2021). The advantage of electronic modules lies in their accessibility, as they can be accessed through students' smartphones or laptops, and they contain instructions, plans, and steps for implementing the learning process, including instructional videos that can be accessed through links provided within the modules.

This research lies in offering novelty to teachers and students which lies in the integration of PBL methods in digital modules, which are strategically designed to enrich the learning process in secondary schools. This e-module not only increases student engagement and learning motivation through the use of technology relevant to the digital era, but also improves students' HOTS skills in a structural and interactive way. Thus, this e-module offers a new approach in designing learning materials that can improve educational effectiveness and student learning outcomes. Therefore, one of the efforts to address the issues faced at SMA 1 Batik Surakarta is by utilizing an innovative learning media, namely e-modules, for the Computer Science subject along with problem-based learning syntax. Based on the aforementioned description, this research aims to develop problem-based learning e-modules that feasible for Computer Science subjects in high school students.

2. METHODS

This study is classified as Research and Development (R&D) method, one of the R&D models adopted to conduct this research is the ADDIE model which stands for Analysis, Design, Development, Implementation, and Evaluation. The selection of this model is based on the consideration that it is one of the systematic models guided by the theoretical foundation of instructional design, thus it is highly relevant to the case of learning product development (Ghofur, 2022; Maryani et al., 2022; Rapitasari & Ganing, 2022). The research itself will focus on determining the feasibility of the product from the perspectives of experts, practitioners, and students (on a small scale). Therefore, the subjects involved in this research consisted of experts, namely two media experts, two learning media experts, and one learning design expert who assessed the product, then the total number of students was 3 people for the one-on-one test stage, and 9 students for the small-scale trial stage, where all students were selected randomly (Cyntiani Ratnaningsih & I Nyoman Laba Jayanta, 2023; Syahrial et al., 2022). The data collection technique utilized in this research includes non-test techniques such as observation, interviews, and questionnaires. Each technique will employ instruments that are appropriate for the data collection method, for instance, observation of learning activities will use observation sheets as instruments, a list of questions to explore information related to teacher needs will be used as instruments for the interview method. Meanwhile, questions/statements regarding the suitability of e-module media will be used as instruments for the questionnaire. The questionnaire adopted for this research is a structured questionnaire with 5 levels, namely 1-5 (Rejekiningsih et al., 2021; Salim, 2019; Susanti et al., 2021). The criteria of subject matter experts, instructional media experts, instructional design experts, and students are outlined in the Table 1, Tabel 2, Tabel 3 and Tabel 4.

Table 1. Media Expert Instrument Grid

No	Aspect	Indicator
1	Display	1) Suitability and attractiveness of appearance 2) Display layout 3) Background proportionality
2	Technical	1) Operational 2) Can help students learn independently 3) Can be used with available devices 4) The media does not contain advertising

Adaptation from research (Rapitasari & Ganing, 2022; Bustanil S et al., 2019)

Table 2. Material Expert Instrument Grid

No	Aspect	Indicator
1	Aspects of Learning Material Quality	1) Material Coverage 2) Material Accuracy 3) Factual and contextuality of material
2	Aspects of Feasibility of Presentation	1) Presentation Method 2) Presentation Support 3) Completeness of Material Presentation

Adaptation from research (Rachmawati, 2020; Bustanil S et al., 2019)

Table 3. Learning Design Expert Instrument Grid

No	Aspect	Indicator
1	Material Delivery Strategy	1) Variation of learning activities 2) Variations in the use of learning resources 3) Class management during the learning process 4) Strategy for delivering material
2	Evaluation	1) Accuracy of integration of material into the media 2) The accuracy of the media for measuring learning outcomes 3) Application of message design principles to the media

Adaptation from research (Cyntiani Ratnaningsih & I Nyoman Laba Jayanta, 2023; Harianto & I Gde Wawan Sudatha, 2024)

Table 4. Instrument Grid for Student Trials

No	Aspect	Indicator
1	Attractiveness and Ease of Use of Media	1) Ease of use 2) The attractiveness and accuracy of the media display 3) The attractiveness of images, animation and music in the media 4) The media contains elements of motivating learning 5) Availability of evaluation practice questions 6) Learning Process

Adaptation from research (Harianto & I Gde Wawan Sudatha, 2024; Rahayu & Sukardi, 2021)

Meanwhile, the instruments that have been created for each validator are first validated through consultation with experts. This validation process involves selecting an expert from each type of instrument to consult on the quality and validity of the electronic module assessment questionnaire from various perspectives. Subsequently, the data obtained from the questionnaire results will be analyzed. In this study, data analysis will be conducted using descriptive techniques, referring to the average assessment of the total validation results. The analysis of the suitability level of the e-module must obtain a minimum percentage score of 61% to be considered suitable as a learning medium. The Table 5 presents the conversion criteria for the suitability of the e-module based on previous research (Andriyani & Suniasih, 2021; Dinayusadewi & Agustika, 2020; Sugiyono, 2018).

Table 5. E-Module Eligibility Criteria

No	Percentage	Qualification	Decision
1	81 – 100%	Very good	Eligible without Revision
2	61 – 80%	Good	
3	41 – 61%	Enough	Eligible with Revision
4	21 – 40%	Deficient	Not Eligible
5	<20%	Very less	

Adapted from (Dinayusadewi & Agustika, 2020)

As previously explained, the development model used in this research will follow the ADDIE model, the development model employed follows the ADDIE framework, which encompasses stages of analysis, design, development, implementation, and evaluation. However, the research will be conducted up to the implementation stage only, where the media will be tested to assess the product's feasibility. The following provides an overview of the research and development procedures used. The following research design is presented in Figure 1.

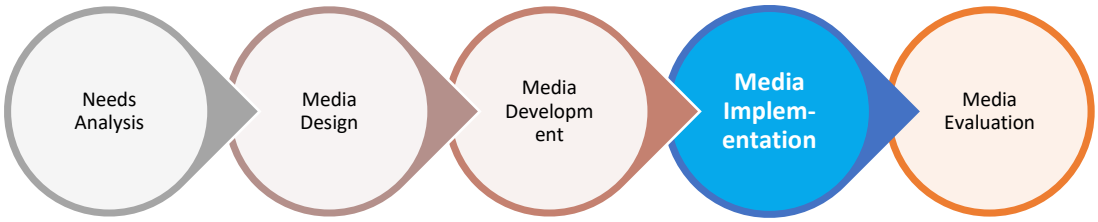

Figure 1. Research Design

3. RESULT AND DISCUSSION

Results

This analysis phase is focused on determining the need for an e-module as an innovation to enhance the low Higher Order Thinking Skills (HOTS) of high school students, with the integration of Problem Based Learning (PBL) approach. The results of this analysis will serve as a guideline in the development of innovative e-modules. In the design phase, the content to be included in the e-module will be determined, taking into consideration the need to enhance students' HOTS abilities. Subsequently, learning outcomes and learning achievement indicators related to HOTS abilities will be prepared. The proposed teaching practices will align with the PBL approach and the developed e-module, and assessment instruments will be designed accordingly. The innovative e-module to enhance high school students' HOTS abilities will begin with a cover page that aligns with the learning objectives. Furthermore, there will be an introduction section that explains the e-module's identity, instructions for usage, and a table of contents to facilitate students in finding desired pages. This will be followed by a description of the material, illustrative images, and integrated learning steps with the PBL approach, accompanied by videos accessible through links.

After the design stage, the next step is the development phase of PBL-based e-modules. In this phase, the ideas from the design will be implemented into concrete e-modules. The content of the e-modules will be created, including materials to enhance students' higher-order thinking skills. The PBL approach will be fully integrated into the e-modules, including the design of learning activities and challenging tasks. This phase is crucial in creating e-modules that are suitable for the learning process. Some opinions suggest that this phase is part of media evaluation, but the research team has examined several relevant studies and referred to the analysis results, stating that the development phase is both the media development stage and the validation process by experts. Therefore, in this phase, besides developing the product, the aim is also to assess the quality and feasibility of the product. The essence of the expert assessment is to ensure that the developed media has minimal errors and is easy to implement for both teachers and students. The analysis results obtained from the e-module validation test can be seen in Table 6.

Table 6. E-Module Evaluation Results by Experts

Validator	Percentage (%)	Qualification	Decision
Media Expert I	88%	Very good	Eligible
Media Expert II	87%	Very good	
Material Expert I	84%	Very good	
Material Expert II	80%	Good	
Learning Designer Expert	78%	Good	
Rata – rata (%)	83%	Very good	

The evaluation by the validators confirms that overall, the quality of the developed media is very good. The assessments provided by two media experts, namely 88% and 87%, indicate that the media content is very good and appropriate. Meanwhile, the assessment from the subject matter expert of 84% also shows good material quality. Despite variations in the assessments, with Subject Matter Expert II giving an assessment of 80%, it still falls within the good category. The assessment provided by the instructional designer expert of 78% is also considered good. Despite variations in the assessments, the overall average validation by the experts reaches 83%, in line with the qualification of "Very Good". Therefore, it can be concluded from the evaluation results conducted by the experts that the learning media in e-module format meets the standards and it can be decided that this e-module is suitable for use as a learning tool and can be continued to the next testing phase. After being declared valid based on the validation test, the e-module is then tested for its practicality in the learning process, this stage is included in the implementation stage. Implementing the practicality test of this Teaching e-module involves students as potential users of the product being developed. The results of the feasibility or practicality test of the media from the student's perspective consist of individual tests and small group tests. The analysis results of these two tests can be seen in Table 7 and Table 8.

Table 7. Individual Test Results

Students (S)	Percentage (%)	Average	Qualification	Decision
S1	86%	83%	Sangat Baik	Eligible
S2	80%			
S3	82%			

Table 8. Small Group Test Results

Students (S)	Percentage (%)	Average	Qualification	Decision
S1	82%	85%	Sangat Baik	Eligible
S2	82%			
S3	89%			
S4	80%			
S5	77%			
S6	85%			
S7	89%			
S8	88%			
S9	85%			
S10	92%			
S11	88%			

Upon examining the two tables above, it is evident that the students have provided evaluations on the practicality of the developed e-module. The results indicate that both individual and small group testing yielded excellent qualifications, with an average percentage of 83% and 85% respectively. Consequently, the e-module product, which has undergone feasibility testing with students, is deemed 'suitable' as a learning media.

Discussion

Generally, it is well known that the purpose of this research is to produce an electronic module or e-module based on problem-based learning for Informatics education in high schools. As a result, the PBL-based e-module is oriented towards learning activities that are integrated with relevant problems related to the topics being taught. The material presented in the media is not limited to narrative texts, but also

includes images, videos, animations, and background music that support the creation of an interactive learning environment for students. After undergoing a series of assessments by experts and students as potential users, it can be concluded that the problem-based learning-based e-module qualifies as excellent and is deemed suitable as a learning media. Several experts validate or assess the e-module, for example, the evaluation results from learning design experts indicate that the use of e-modules falls into the category of suitability. They believe that an attractive e-module product will be able to enhance student motivation. This e-module is developed according to the needs and characteristics of problem-based learning, which can improve their learning motivation (Astalini et al., 2019; Syahrial et al., 2022). The use of problem-based learning methods, such as the Problem Based Learning (PBL) approach, in several studies has shown empirical evidence that significantly enhances student learning motivation compared to lecture methods (Rahman et al., 2018; Nurtanto et al., 2020). Therefore, this product is a highly appropriate integration to support computer science education, which is considered essential for students to master.

The analysis results indicate that a good media must fulfill several inherent validity aspects. For example, expert material assessments state that this media has excellent material quality. This is closely related to the clarity of the learning objectives conveyed in the e-module, the clarity of the material presented, and the ability to present the material in enhancing student engagement during the learning process. These findings are consistent with several previous research and development studies that show that the clarity of the learning objectives conveyed in the e-module, the clarity of the material presented, and the ability to present the material in enhancing student engagement during the learning process are crucial aspects that cannot be overlooked. Similar research conducted by other researchers, shows that e-module products validated by material experts, in order to ensure accuracy and depth of the material in accordance with students' characteristics, thus enabling students to truly learn according to their needs (Aufa et al., 2021; Sofyan et al., 2019). Therefore, the findings of this research provide additional support for the theory that learning media that meet certain validity standards are more recommended in facilitating the learning process.

In line with this, the validation results conducted by media experts also indicate that the e-module product meets the elements of navigation, user-friendliness, and proportional display when presenting materials in the form of text, instructional videos, animations, and graphics. It is known that one of the advantages of the e-module product is the availability of videos, animations, and images that are considered attractive and helpful in understanding the material by students (Ningtyas & Jati, 2018; Johan et al., 2022). The findings of this research are supported by several studies stating that Problem-Based Learning (PBL)-based e-modules are considered to enhance learning outcomes in subjects such as Biology and Mathematics for high school students, due to the assumption that e-modules have been designed to engage students in independent thinking and problem-solving, in line with the principles of PBL (Hadiyanti et al., 2021; Sari et al., 2021). In learning that fully utilizes digital technologies like today, the need for digital-based learning products such as e-modules, integrated with PBL, can facilitate independent thinking and critical thinking (Cantona et al., 2023; Habibi et al., 2022). These findings emphasize the value of integrating PBL strategies into e-module development to promote critical thinking and problem-solving skills among high school students. Furthermore, the research results indicate that integrating PBL into learning products can have a positive impact on learning outcomes, making this research appropriate for adopting the PBL approach.

Overall, the study on PBL-based e-modules for high school students underscores the significance of utilizing a problem-based learning strategy to enhance students' learning experiences, foster critical thinking, and boost students' HOTS abilities in informatics subjects. The successful development of the PBL-based e-module in this study is undoubtedly attributed to the relevant research that has been conducted, emphasizing the potential and benefits of e-module learning on a broader scale. A notable aspect of this study is the introduction of an integrated e-module product with the PBL approach, specifically tailored for informatics education in high schools. Nevertheless, the study is limited in that it primarily focuses on product development and evaluating the media's suitability from the perspectives of experts and students, without delving into the impact of its implementation. Despite these limitations, it is believed that this research can provide valuable insights through the development of effective e-modules that facilitate students' problem solving skills in informatics subjects, both in theory and practice. So, it can be interpreted that this research apart from contributing theoretically to the science of educational technology, this research also has implications for the presence of various kinds of innovation and integration between innovative learning models and interactive learning media that have a high level of accessibility and interactivity, namely e-modules. Meanwhile, a suggestion for further research is to use a holistic approach in measuring the impact of using this e-module on students' achievement and learning abilities, which may be implemented in the coming months.

4. CONCLUSION

Based on the findings presented and the review of the issues raised, it can be concluded that this development research has successfully achieved its objectives by creating a PBL-based e-module that feasible to implement in learning activities. The feasibility of this product is inseparable from the support of supporting elements in the development of the e-module, as well as input from experts that support the validity and applicability of the resulting e-module. This e-module is expected to make a significant contribution in learning activities, especially in sociology learning.

5. REFERENCES

Abdulah, A., Mustadi, A., & Fitriani, W. (2021). PBL-Based Interactive Multimedia in Improving Critical Thinking Skills. *JPI (Jurnal Pendidikan Indonesia)*, *10*(1), 136. https://doi.org/10.23887/jpi-undiksha.v10i1.25521.

Andriyani, N. L., & Suniasih, N. W. (2021). Development of Learning Videos Based on Problem-Solving Characteristics of Animals and Their Habitats Contain in Ipa Subjects on 6th-Grade. *Journal of Education Technology*, *5*(1), 37. https://doi.org/10.23887/jet.v5i1.32314.

Arafah, K., Amin, B. D., Sari, S. S., & Hakim, A. (2021). The Development of Higher Order-Thinking Skills (HOTS) Instrument Assessment in Physics Study. *Journal of Physics: Conference Series*, *1899*(1). https://doi.org/10.1088/1742-6596/1899/1/012140.

Arican, S., & Mutlu, Ş. (2023). 21st-Century Learning Skills and School Climate Levels of Anatolian Imam Hatip High School Students. *Ankara Universitesi Ilahiyat Fakultesi Dergisi*, *64*(2), 699–742. https://doi.org/10.33227/auifd.1347688.

Astalini, Darmaji, Kurniawan, W., Anwar, K., & Kurniawan, D. A. (2019). Effectiveness of using e-module and e-assessment. International Journal of Interactive Mobile Technologies, 13(9), 21–39. https://doi.org/10.3991/ijim.v13i09.11016.

Aufa, M. N., Rusmansyah, R., Hasbie, M., Jaidie, A., & Yunita, A. (2021). The Effect of Using e-module Model Problem Based Learning (PBL) Based on Wetland Environment on Critical Thinking Skills and Environmental Care Attitudes. *Jurnal Penelitian Pendidikan IPA*, *7*(3), 401–407. https://doi.org/10.29303/jppipa.v7i3.732.

Bustanil S, M., Asrowi, & Adianto, D. T. (2019). Pengembangan Media Pembelajaran Interaktif Berbasis Video Tutorial Di Sekolah Menengah Kejuruan. *JTP - Jurnal Teknologi Pendidikan*, *21*(2), 119–134. https://doi.org/10.21009/jtp.v21i2.11568.

Cantona, I. G. E., Suastra, I. W., & Ardana, I. M. (2023). HOTS Oriented Problem-Based Learning Model: Improving Critical Thinking Skills and Learning Outcomes of Fifth Grade Students in Science Learning. *Thinking Skills and Creativity Journal*, *6*(1), 19–26. https://doi.org/10.23887/tscj.v6i1.

Cyntiani Ratnaningsih, M. N., & I Nyoman Laba Jayanta. (2023). Digital Teaching Module on Teaching Practice Material Based on Value Clarification Technique (VCT). *Journal of Education Technology*, *7*(3), 429–438. https://doi.org/10.23887/jet.v7i3.61649.

Dinayusadewi, N. P., & Agustika, G. N. S. (2020). Development Of Augmented Reality Application As A Mathematics Learning Media In Elementary School Geometry Materials. *Journal of Education Technology*, *4*(2), 204. https://doi.org/10.23887/jet.v4i2.25372.

Fauzi, C., & Basikin. (2020). The Impact of the Whole Language Approach Towards Children Early Reading and Writing in English. *JPUD - Jurnal Pendidikan Usia Dini*, *14*(1), 87–101. https://doi.org/10.21009/JPUD.141.07.

Fitriani, W., Abdulah, A., & Mustadi, A. (2021). The Use Of PBL-Based Interactive Multimedia To Develop Student Science Process Skill. *Jurnal Pendidikan Dan Pengajaran*, *54*(1), 150. https://doi.org/10.23887/jpp.v54i1.34256.

Ghofur, A. (2022). Digital Comic Media on Smartphones to Improve Communication Skills. *Journal of Innovation in Educational and Cultural Research*, *3*(3). https://doi.org/10.46843/jiecr.v3i3.149.

Habibi, M., Sunardi, & Sudiyanto. (2022). Identification of Opportunities for Utilizing E-Modules with a Problem Based Learning Approach to Facilitate Learning in Vocational High Schools. *Jurnal Edutech Undiksha*, *10*(2), 311–322. https://doi.org/10.23887/jeu.v10i2.52722.

Hadianto, A., & Festiyed. (2020). Meta analysis the use of e-modules based on research based learning models. *Journal of Physics: Conference Series*, *1481*(1). https://doi.org/10.1088/1742-6596/1481/1.

Hadiyanti, N. F. D., Hobri, Prihandoko, A. C., Susanto, Murtikusuma, R. P., Khasanah, N., & Maharani, P. (2021). Development of mathematics e-module with STEM-collaborative project based learning to improve mathematical literacy ability of vocational high school students. *Journal of Physics: Conference Series*, *1839*(1). https://doi.org/10.1088/1742-6596/1839/1/012031.

Harianto, N. A., & I Gde Wawan Sudatha. (2024). Interactive Multimedia with Problem-Based Learning in Mathematics. *Journal of Education Technology*, *7*(4), 610–618. https://doi.org/10.23887/jet.v7i4.64656.

Iqbal, R. M., Feranie, S., Illene, S., & Salsabila, G. A. (2023). 21st century skills profile in linear motion topic in one of junior high school in Bandung. In R. R., G. S.M., J. A., N. A.B.D., S. A., & R. L.S. (Eds.), *AIP Conference Proceedings* (Vol. 2734, Issue 1, p. 873). American Institute of Physics Inc. https://doi.org/10.1063/5.0156185.

Ismail, N. S., Harun, J., Zakaria, M. A. Z. M., & Salleh, S. M. (2018). The effect of Mobile problem-based learning application DicScience PBL on students' critical thinking. *Thinking Skills and Creativity*, *28*, 177–195. https://doi.org/10.1016/j.tsc.2018.04.002.

Johan, R. C., Rullyana, G., & Ardiansah, A. (2022). Hyper content e-module in information behavior course with the assistant of screencast. Journal of Education and Learning (EduLearn), 16(2), 210–218. https://doi.org/10.11591/edulearn.v16i2.20339.

Ketut Sri Puji Wahyuni, I Made Candiasa, & I Made Citra Wibawa. (2021). PENGEMBANGAN E-LKPD BERBASIS KEMAMPUAN BERPIKIR TINGKAT TINGGI MATA PELAJARAN TEMATIK KELAS IV SEKOLAH DASAR. *PENDASI: Jurnal Pendidikan Dasar Indonesia*, *5*(2), 301–311. https://doi.org/10.23887/jurnal_pendas.v5i2.476.

Luciana, N. L. R. (2020). Teachers' Readiness in Inserting the 21st Century Skills in the Lesson Plan in Teaching English. *Jurnal Pendidikan Dan Pengajaran*, *53*(2), 168. https://doi.org/10.23887/jpp.v53i2.26406.

Maharani Zan, A., & Mardian, V. (2022). The Impact of Static Fluid E-Module by Integrating STEM on Learning Outcomes of Students. Journal of Education Technology, 6(1). https://doi.org/10.23887/jet.v6i1.42458.

Malik, R. S. (2018). Educational challenges in 21st century and sustainable development. *Journal of Sustainable Development Education and Research*, *2*(1), 9–20. https://doi.org/10.17509/jsder.v2i1.12266.

Maryani, I., Prasetyo, Z. K., Wilujeng, I., & Purwanti, S. (2022). Higher-order Thinking Test of Science for College Students Using Multidimensional Item Response Theory Analysis. *Pegem Egitim ve Ogretim Dergisi*, *12*(1), 292–300. https://doi.org/10.47750/pegegog.12.01.30.

Maryani, I., Prasetyo, Z. K., Wilujeng, I., Purwanti, S., & Fitrianawati, M. (2021). HOTs Multiple Choice and Essay Questions: A Validated Instrument to Measure Higher-order Thinking Skills of Prospective Teachers. *Journal of Turkish Science Education*, *18*(4), 674–690. https://doi.org/10.36681/tused.2021.97.

Masnur, M., Masnur, M., Syaparuddin, S., & Syaparuddin, S. (2019). The Effect of POGIL Learning Model on HOTS Students of Elementary School Teacher Education Program. *Edumaspul: Jurnal Pendidikan*. https://doi.org/10.33487/edumaspul.v3i2.145.

Mursyid, M., & Kurniawati, N. (2019). Higher Order Thinking Skills Among English Teachers Across Generation In Efl Classroom. *English Review: Journal of English Education*, *7*(2). https://doi.org/10.25134/erjee.v7i2.1775.

Ningtyas, R. K., & Jati, H. (2018). Project-Based Electronic Module Development As A Supporting Learning Media For Basic Programming Learning. *Journal of Educational Science and Technology (EST)*, 221–227. https://doi.org/10.26858/est.v1i1.6999.

Notanubun, Z. (2019). Pengembangan Kompetensi Profesionalisme Guru di Era Digital (Abad 21). *Jurnal Bimbingan Dan Konseling Terapan*, *3*(2), 54. https://doi.org/10.30598/jbkt.v3i2.1058.

Novitra, F., Festiyed, Yohandri, & Asrizal. (2021). Development of Online-based Inquiry Learning Model to Improve 21st-Century Skills of Physics Students in Senior High School. *Eurasia Journal of Mathematics, Science and Technology Education*, *17*(9), 1–20. https://doi.org/10.29333/ejmste/11152.

Nurhayati, Nurhayati, Wahyudi, Wahyudi, W., Angraeni, L., & Angraeni, L. (2021). The influence of problem based learning model and critical thinking ability on higher order thinking skills (HOTs) of physics prospective teachers students. *Journal of Physics: Conference Series*, *2104*. https://doi.org/10.1088/1742-6596/2104/1/012007.

Nurtanto, M., Fawaid, M., & Sofyan, H. (2020). Problem Based Learning (PBL) in Industry 4.0: Improving Learning Quality through Character-Based Literacy Learning and Life Career Skill (LL-LCS). *Journal of Physics: Conference Series*, *1573*(1). https://doi.org/10.1088/1742-6596/1573/1/012006.

Nurtanto, M., Sofyan, H., Fawaid, M., & Rabiman, R. (2019). Problem-based learning (PBL) in industry 4.0: Improving learning quality through character-based literacy learning and life career skill (LL-LCS). *Universal Journal of Educational Research*, *7*(11), 2487–2494. https://doi.org/10.13189/ujer.2019.071128.

Pamungkas, S. F., Widiastuti, I., & Suharno. (2020). 21st century learning: Experiential learning to enhance critical thinking in vocational education. In *Universal Journal of Educational Research* (Vol. 8, Issue 4, pp. 1345–1355). https://doi.org/10.13189/ujer.2020.080427.

Permana, M. P., & Syahruzah, J. K. (2023). Making Learning Media for HOTS-Based Transmission Course. In *Proceedings of the 1st UPY International Conference on Education and Social Science (UPINCESS 2022)*. https://doi.org/10.2991/978-2-494069-39-8_41.

Permatasari, B. D., Gunarhadi, G., & Riyadi, R. (2019). The influence of problem based learning towards social science learning outcomes viewed from learning interest. *International Journal of Evaluation and Research in Education (IJERE)*, *8*(1), 39. https://doi.org/10.11591/ijere.v8i1.15594.

Rachmawati, D. (2020). Efektivitas Penggunaan Media Video Dalam Meningkatkan Hasil Belajar Praktik Siswa SMK Tata Busana. *Jurnal Online Tata Busana*, *09*(3), 80–89. https://jonedu.org/index.php/joe/article/view/2629.

Rahayu, I., & Sukardi, S. (2021). The Development Of E-Modules Project Based Learning for Students of Computer and Basic Networks at Vocational School. *Journal of Education Technology*, *4*(4), 398. https://doi.org/10.23887/jet.v4i4.29230.

Rahman, F., Yurniwati, Y., & Bintoro, T. (2018). Pengaruh Model Problem Based Learning (PBL) terhadap Kemampuan Pemecahan Masalah Matematika ditinjau dari Metakognisi Belajar Siswa Sekolah Dasar. *Indonesian Journal of Primary Education*, *2*(1), 48. https://doi.org/10.17509/ijpe.v2i1.11648.

Ran, W., & Jinglu, L. (2020). The Design and Development of Digital Books for E-learning. *2020 4th International Conference on Artificial Intelligence and Virtual Reality*, 51–55. https://doi.org/10.1145/3439133.3439140.

Rapitasari, N. P. R. N., & Ganing, N. N. (2022). Wondershare Filmora-Based Learning Video on Material Body Parts of Plants Class IV Science Learning Content. *Journal for Lesson and Learning Studies*, *5*(3), 487–495. https://doi.org/10.23887/jlls.v5i3.56018.

Rejekiningsih, T., Budiarto, M. K., & Sudiyanto, S. (2021). Pengembangan multimedia interaktif berbasis potensi lokal untuk pembelajaran prakarya dan kewirausahaan di SMA. *Kwangsan: Jurnal Teknologi Pendidikan*, *9*(2), 167. https://doi.org/10.31800/jtp.kw.v9n2.p167--185.

Salim, H. (2019). Penelitian Pendidikan : Metode, Pendekatan, dan Jenis. In *Jakarta: Kencana*. https://books.google.co.id/books/about/Penelitian_Pendidikan_Metode_Pendekatan.

Sari, S. E., Susilawati, S., & Anwar, L. (2021). E-Module Development on Hydrocarbon Compounds Material for Class X Agricultural Vocational High School. *Journal of Educational Sciences*, *5*(1), 36. https://doi.org/10.31258/jes.5.1.p.36-52.

Silalahi, D. E., Silalahi, D. E., Herman, H., Herman, H., Sihombing, P. S. R., Sihombing, P. S. R., Damanik, A. S., Damanik, A. S., Purba, L., & Purba, L. (2022). An Analysis of Students' Achievement in Reading Comprehension through Higher Order Thinking Skills (HOTS). *Al-Ishlah*, *14*(2), 1853–1868. https://doi.org/10.35445/alishlah.v14i2.1249.

Simanjuntak, M. P., Hutahaean, J., Marpaung, N., & Ramadhani, D. (2021). Effectiveness of problem-based learning combined with computer simulation on students' problem-solving and creative thinking skills. *International Journal of Instruction*, *14*(3), 519–534. https://doi.org/10.29333/iji.2021.14330a.

Sofyan, H., Anggereini, E., & Saadiah, J. (2019). Development of E-Modules Based on Local Wisdom in Central Learning Model at Kindergartens in Jambi City. *European Journal of Educational Research*, *8*(4), 1137–1143. https://doi.org/10.12973/eu-jer.8.4.1139.

Suanto, E., Armis, A., & Suhermi, S. (2020). Pengembangan Bahan Ajar Matematika Berazaskan Experiential Learning Untuk Meningkatkan Kemahiran Berpikir Tingkat Tinggi Siswa SMP. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, *4*(2), 1300–1310. https://doi.org/10.31004/cendekia.v4i2.365.

Sugiyono, D. (2018). Metode penelitian kuatintatif , kualitatif dan R & D. In *Bandung: Alfabeta*. https://inlislite.uin-suska.ac.id/opac/detail-opac?id=22862.

Susanti, T., Kurniadewi, F., & Nurjayadi, M. (2021). Development of protein metabolism electronic module by flip PDF professional application. *Journal of Physics: Conference Series*, *1869*(1). https://doi.org/10.1088/1742-6596/1869/1/012025.

Susantini, E., Puspitawati, R. P., Raharjo, & Suaidah, H. L. (2021). E-book of metacognitive learning strategies: design and implementation to activate student's self-regulation. *Research and Practice in Technology Enhanced Learning*, *16*(1). https://doi.org/10.1186/s41039-021-00161-z.

Syahrial, S., Asria, A., Sabil, H., Kurniawan, D. A., Perdana, R., & Kiska, N. D. (2022). Development of E-Module Based on the Traditional Puyuh Game on the Cooperation Character and the Tolerance of Elementary School Students. *Journal of Innovation in Educational and Cultural Research*, *3*(3). https://doi.org/10.46843/jiecr.v3i3.154.

Tam, N. T. M. (2018). Using Problem-Based Learning To Promote Students' Use of Higher-Order Thinking Skills and Facilitate Their Learning. *VNU Journal of Foreign Studies*, *34*(2), 90–91. https://doi.org/10.25073/2525-2445/vnufs.4249.

Trevallion, D., & Nischang, L. C. (2021). The Creativity Revolution and 21 st Century Learning. *International Journal of Innovation, Creativity and Change*, *15*(8), 1–25. https://erioluwaadeyinka.medium.com/how-traditional-educational-system-is-affecting..

Tyan, P. H., Rahman, F. A., & Sarvestani, M. S. (2020). Teachers' readiness in implementing and facilitating 21st century learning. *Universal Journal of Educational Research*, *8*(1 A), 24–29. https://doi.org/10.13189/ujer.2020.081304.

Yoda, I. K., Kasih, I., & Ilra, T. (2024). Developing an e-module to improve the seventh-grade student's bump pass skills in volleyball. *Journal of Education and E-Learning Research*, *11*(1), 17–25. https://doi.org/10.20448/jeelr.v11i1.5286.

Yong, M. F., & Saad, W. Z. (2023). Fuelling Grammar Mastery and 21st Century Skills Through Project-Based Learning. *Pertanika Journal of Social Sciences and Humanities*, *31*(1), 99–124. https://doi.org/10.47836/PJSSH.31.1.06.