JPPIPA 10(1) (2024)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

Development of PBL Based E-Modules to Boost Students' Science Process Skills

Azrul Hamidi[1*], Rida Akmala[1], Suyanta[1], Insih Wilujeng[1]

[1] Magister of Science Education Department, Universitas Negeri Yogyakarta, Yogyakarta, Indonesia.

Received: November 1, 2023
Revised: January 4, 2024
Accepted: February 25, 2024
Published: February 29, 2024

Corresponding Author:
Azrul Hamidi
azrulhamidi.2022@student.uny.ac.id

DOI: 10.29303/jppipa.v10i2.5939

Abstract: This research is Research and Development (R&D) research that follows the ADDIE development model which integrates five stages including analysis, design, development, implementation and evaluation. This research aims to produce a PBL-based e-module that is able to stimulate and improve students' science process skills. This research uses a number of assessment instruments to measure the quality and effectiveness of the e-module being developed, including an e-module validation sheet, a practicality assessment sheet by the teacher, and an observation sheet on students' science process skills. These instruments help researchers gain an in-depth understanding of the extent to which the e-modules developed meet the criteria for success and relevance in improving student learning, especially students' science process skills. The e-module validation results show that the e-module is valid with a percentage of 89.02% reaching very feasible criteria. The practical results of this e-module are very practical in terms of material, appearance, language and use. The results of observations of students' science process skills when using PBL-based e-module products are also very suitable for all student groups. From these results it is concluded that the e-module can be used in the class VII science learning process regarding classification of materials and their changes.

Keywords: E-modules; PBL; Science process skills

Introduction

The 21st century brings high demands on every individual, requiring them to master a variety of skills and abilities. In this era, skills such as being able to collaborate, thinking critically and creatively, having learning and innovation skills, being able to utilize technology and information, and being able to work together using the skills they have (Yanuarni et al., 2021). Redhana (2019) explains that the preparation of human resources who are able to effectively master 21st century skills can be achieved through the education system. 21st century education is education that combines knowledge, skills and attitudes and identifies learning sources from this knowledge, skills and attitudes. We must ensure that 21st century education is in line with the demands of the times (Astuti et al., 2023; Cynthia et al., 2023). In this case, educators act as a foundation for raising national education standards and are equipped to teach students how to live in the 21st century (Usman et al., 2021).

Many parties, including observers and education experts, have acknowledged the poor quality of education in Indonesia and that this must be a major concern. According to the OECD (2019) Indonesia has participated in the Program for International Student Assessment or "PISA" since 2001. Since then, science scores have fluctuated but have generally remained stable, while reading and mathematics scores have not been too high. While math scores fluctuated more in the early years of PISA, but have remained relatively stable since 2009, reading scores in 2018 returned to 2001 levels after peaking in 2009. In general, from the PISA assessment results, Indonesia's educational performance is still below expected standards. Education in Indonesia should prioritize meaningful education, especially science education. In Indonesia, only a very small number of students excel in science. To overcome this,

How to Cite:
Hamidi, A., Akmala, R., Suyanta, & Wilujeng, I. (2024). Development of PBL Based E-Modules to Boost Students' Science Process Skills. *Jurnal Penelitian Pendidikan IPA*, *10*(2), 820–827. https://doi.org/10.29303/jppipa.v10i2.5939

various breakthroughs need to be made in science education, especially in improving the quality of science learning (Suryaneza & Permanasari, 2016).

In this fast-paced and dynamic digital era, science learning needs to be directed at developing students' science process skills (KPS). KPS is a skill needed to carry out scientific explanations, starting from describing problems, collecting data, analyzing data, and drawing conclusions. KPS is very important for students to have so that they can solve problems scientifically. Dogan et al. (2016) believes that science process skills (KPS) are skills that facilitate scientific learning, foster the ability to explore, learn actively, and develop a sense of responsibility when learning. However, findings by Fredy et al. (2019) show that students are reluctant to ask, answer, observe, and communicate their findings in science learning. This finding shows that students are still not skilled in using KPS in science learning. This can be caused by several factors, such as teachers who do not emphasize the importance of KPS in learning. Learning that focuses too much on memorization. Lack of opportunities for students to practice KPS. Science process skills are needed to solve problems scientifically. Therefore, teachers must demonstrate and teach science process skills to students, because these skills are useful for developing students' scientific attitudes (Darmaji et al., 2018; Maison et al., 2019).

The problem-based learning (PBL) approach is a learning model that offers the potential to improve students' science process skills (Duda et al., 2019). Research conducted by Hidayah et al. (2016) shows that there is a positive and significant influence using the PBL model on the development of students' science process skills. In essence, the PBL learning model emphasizes that students are not taught lessons in their final form but must organize them themselves. This condition will provide strong motivation and encouragement towards students' science process skills. Therefore, it is necessary to develop PBL based learning materials. It is hoped that the teaching materials developed in PBL can enable students to analyze and investigate independently or in groups, thus creating an attitude towards the scientific process. Dewi et al. (2023) said that teaching materials, especially digital, are one of the teaching materials that are good enough to be applied in PBL learning so that they can increase students' KPS.

Teaching materials are anything that can be used as a tool in the learning process. Teaching materials can be in the form of books, modules, learning media, etc. Quality teaching materials can help students to achieve learning goals. Teaching materials also have an important meaning in the learning process with the aim of making students more motivated in learning and practicing independence to achieve the skills expected in science learning. Teachers are expected to be able to develop teaching materials that are not only focused on one source. Innovating teaching materials can provide meaningful experiences for students (Lestari et al., 2020). One of the popular teaching materials is a module. Modules are a type of teaching material designed in a study guide that students can use without guidance from other people (Syamsussabri et al., 2019). Well-designed modules can provide meaningful learning experiences for students. Students can use modules independently and directedly to acquire skills, especially science process skills (Sueb & Damayanti, 2021).

Educators must create lesson plans that are organized, distinctive, engaging, and appropriate for the twenty-first century. This paradigm must be supported by the educational resources that are used in the classroom, such as by digitizing the materials into electronic format (Asrizal et al., 2022). The ease of accessing information through technology makes electronic teaching materials the right choice for students as a learning resource. In the current digital era, students rarely open or read conventional books (Laksana et al., 2019). Electronic modules are an alternative solution in improving 21st century skills. According to Anggraeni et al. (2022) in an effort to keep up with current developments, especially education, modules are made in electronic form to make them easier, more practical and efficient.

Science learning in junior high school requires an approach that focuses on conceptual understanding and physical analysis of problem situations that can be solved by students. One of the topics taught in class VII science is "classification of materials and their changes". Wulandari et al. (2023) said that through understanding this material, students can grow their understanding of concepts and science process skills. In this context, researchers want to develop a PBL based e-module product to stimulate students' science process skills regarding classification and change in matter. The E-Module being developed is expected to become a resource to support the learning process for teachers and students.

Method

This research is included in a type of development research, known as Research and Development (R&D), which aims to create products that have practical and useful value (Desyandri et al., 2019; Oktarina et al., 2023). This development research refers to the ADDIE model. This development research approach refers to the ADDIE model. In this model, the PBL-based e-

module development process is carefully designed, allowing the development of products that suit learning needs and objectives. According to Spatioti et al. (2022) this approach was first presented at the University of Florida in 1975, and educational designers have since utilized it extensively to create training and educational initiatives. The name ADDIE is an acronym that describes the five basic steps of this learning design and development model, namely Analysis, Design, Development, Implementation, and Evaluation. The following is an overview of the design of the ADDIE model in this development research.

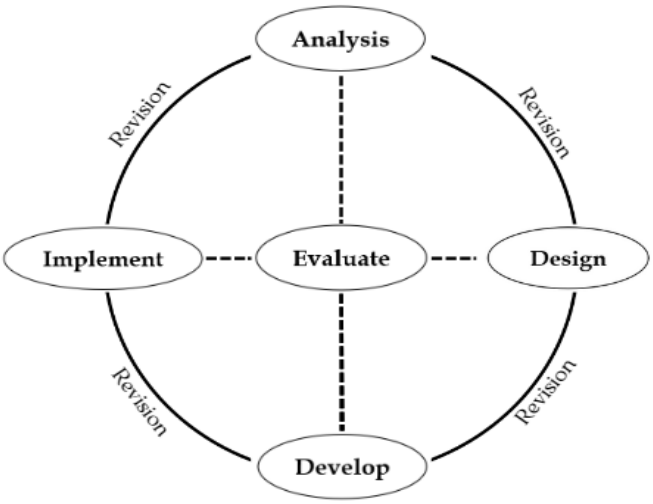

Figure 1. ADDIE model design

The first is the analysis stage, the basic problems that need to be corrected before making e-modules are identified, and the advantages and disadvantages of the teaching materials that teachers have used in schools are known. The concept at this stage is preliminary research which includes teacher interviews, school observations, and material analysis. The results of this analysis will be taken to the next stage, namely designing, namely the product to be developed.

At the design stage, the product to be developed is designed carefully after carrying out initial analysis. Products in the form of electronic modules will be developed using the problem-based learning model or PBL. The main focus in developing this electronic module is to create electronic learning resources that can effectively improve students' science process skills. With a PBL approach, this module is expected to be able to provide students with a more interactive and in-depth learning experience.

The third stage, called the development stage, is a key phase in the PBL based electronic module development process. Development processes such as writing text, placing images, video integration, setting hyperlinks, and compiling a collection of questions. The electronic module created will be validated by the lecturer and two students. This stage also carries out revisions to improve and refine teaching materials so that they can be used for implementation in schools.

The e-Module that has been developed and revised is then implemented in schools. Implementation of the e-module is carried out by taking 1 class at school. The class is chosen randomly to represent all classes in the school. At the implementation stage, 1 class was taken to test how practical the teacher thought it was in using the product. The class teacher was asked to use e-modules to teach. Teachers are asked to provide feedback on how practical the e-module is to use. Furthermore, an observation sheet was also given which was filled in by two observers to see how students' science process skills completed the commands in the PBL-based e-module. Observers recorded the science process skills used by students in completing the commands in the e-module.

An evaluation that is conducted formatively and summatively constitutes the last phase. Summative evaluation is done at the end of the process, contingent on how well the learning process is being applied. Formative evaluation happens at every stage of development. The goal of summative evaluation is to provide reliable and useful products that, because they have been tailored to the demands of schools, can be extensively used in those institutions (Siregar et al., 2023). This product, in the form of a PBL based learning e-module, is also expected to be able to make students have a good attitude towards science process skills.

Result and Discussion

Analysis Stage

Development of a PBL based e-module which aims to improve students' science process skills using five stages, namely analysis, design, product development, product implementation and evaluation. These five stages are carried out to produce PBL based electronic module products to improve students' science process skills. At the analysis stage, observations were made at school and it was found that all students used smartphones without exception. Another thing found in the condition of students, especially class VII, is that they have not used much learning innovation. This is because class VII has just started learning at the 1st semester of junior high school. From this analysis, researchers are interested in developing learning that utilizes electronic technology. Zulyati et al. (2022) said learning using electronics can improve student learning outcomes. Furthermore, according to Adri et al. (2023) using electronic teaching materials learning will be easier and also practical. The hope is that developing electronic

teaching materials will make students innovate in the learning process.

Furthermore, the results of interviews with teachers revealed that the learning model that is routinely applied in class is the problem-based approach (PBL). The teacher explained that the use of this learning model had proven its effectiveness in making students actively involved in the teaching and learning process. Furthermore, the teacher also emphasized that this approach helps prevent boredom in learning so that students remain enthusiastic and focused in carrying out the learning process. This research is in accordance with research conducted by Evendi et al. (2021) which shows that the use and application of the PBL model can have a positive impact on increasing learning outcomes and improving the learning process. However, this research also highlights the importance of motivational factors and the active role of students as key aspects in the successful implementation of the PBL model. We also conducted material analysis interviews with the science material that will be discussed, namely Material Classification and Changes. However, only one source of books is used, namely government textbooks. Researchers are interested in creating e-module based PBL teaching materials to improve students' science process skills with science material, such as Classification and Changes in Materials, based on this initial analysis. According to Nuri et al. (2023) implementing the use of e-modules in learning will provide positive experiences and benefits for students' cognitive, metacognitive and affective outcomes. Furthermore Nurfazliana et al. (2023) says, carrying out learning using PBL-based e-modules will give students a sense of satisfaction in the science learning process so that learning becomes more meaningful.

Design Stage

Next, the second stage is designing and designing the e-module product being developed. The e-module created will be able to be accessed anytime and anywhere by students, so it will make things easier. In figure 2 shows how the development research design is carried out starting from analyzing the problem to convey the plan to be developed.

After understanding and analyzing the challenges in science learning in class VII of junior high school, researchers plan to develop a PBL based e-module product. In order to create a more interesting learning experience, researchers adopted the five stages of PBL syntax developed by Moore (2016). These stages involve defining the problem, collecting data, identifying alternatives, assessing alternatives, and selecting the best. These five PBL syntaxes were then synthesized into sentences specifically designed to be more interesting and relevant for students, and arranged in an e-module format for science subjects. Thus, this e-module is expected to be able to bridge the gap in science learning and improve students' science process skills.

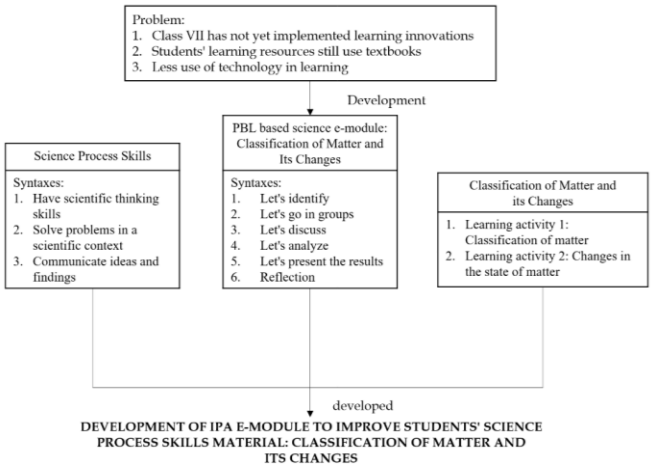

Figure 2. E-Module product development design

The science material that will be included in the e-module is class VII material classification and changes. In the e-module that will be developed, two learning activities will be created, divided into the first learning activity, namely classifying material and the second learning activity, namely changing the state of substances. This product development aims to significantly improve students' science process skills. The syntax of scientific process skills which is the reference, as stated in the Council and National Research (2012), includes three important aspects: first, the ability to use scientific thinking skills, including understanding scientific concepts, application of scientific methods, and analysis and interpretation of scientific data. Second, the ability to use reasoning and problem solving in a scientific context, such as identifying scientific problems, collecting systematic and accurate data, and being able to think logically and critically in solving scientific problems. Third, the ability to convey ideas and findings effectively through writing and presentations, including the use of appropriate scientific language, the ability to explain and defend arguments, and the ability to receive input openly and constructively.

Syntax synthesis of science process skills will be the basis for developing observation sheets that will be used to measure students' science process skills abilities when using this e-module product in their learning process. According to Kurniawan et al. (2023), these science process skills can be developed by providing direct experience to students, who in this research used e-module products developed using PBL. Thus, it is hoped that the development of this product can make a

significant contribution to improving students' science process skills.

Developmentt Stage

The development stage is realizing the plans that have been prepared previously. The e-Module was developed using the Canva application and then the file was made into an online flipbook containing various content, including materials, videos and images. The main advantage of this format is its accessibility, so students can easily access the content via their Android devices or laptops. The process of developing PBL based e-modules went through a validation process involving a lecturer and two science education postgraduate students. The aspects measured in validation are content suitability, presentation components, language assessment, and e-module characteristics. The results of the validation stage are documented in table 1 with the aim of evaluating and ensuring the quality of the learning media that has been produced.

Table 1. Recapitulation of E-Module Validation

Aspect	$(\sum x)$	$(\sum x1)$	Percentage	Criteria
Content eligibility	57	60	95%	Very worth
Presentation components	48	60	80%	Worth
Language assessment	54	60	90%	Very worth
Characteristics e-Module	153	168	91.07%	Very worth
Sum	312	348		
Average			89.02%	Very worth

The results of the validation process show that the average percentage of e-module eligibility is very high, reaching 89.02%. This percentage is divided into several assessment aspects, namely: content feasibility reaches 95%, with very feasible criteria. The presentation component received an assessment of 80% with appropriate criteria. The language assessment reached 90% with very decent criteria. The e-module characteristics obtained the highest percentage, namely 91.07% with very feasible criteria. Based on this validity test, e-modules can be implemented in schools. This is in accordance with research by Subarkah et al. (2021) that e-modules that have been proven valid can be said to be a very feasible and effective learning media.

Implementation Stage

The next step is to implement PBL based e-module products in schools to improve students' science process skills. This e-module will be implemented in class VII E at SMPN 6 Yogyakarta. The implementation of the PBL based e-module will see how practical it is according to the science teacher and analyze the observation sheet of students' science process skills using the e-module product. The observation sheet will be observed by two people. According to Agung et al. (2022) and Mijaya et al. (2021) there are four aspects that are seen in the practicality of an e-module, including clarity of material content, appearance of the e-module, language of the e-module, and usefulness for users. E-modules are said to be practical if the observation results show a significant improvement in the learning process when e-modules are used in the classroom. With this evaluative approach, it is hoped that a deeper understanding can be obtained about the contribution of PBL based e-modules to students' learning and science process skills.

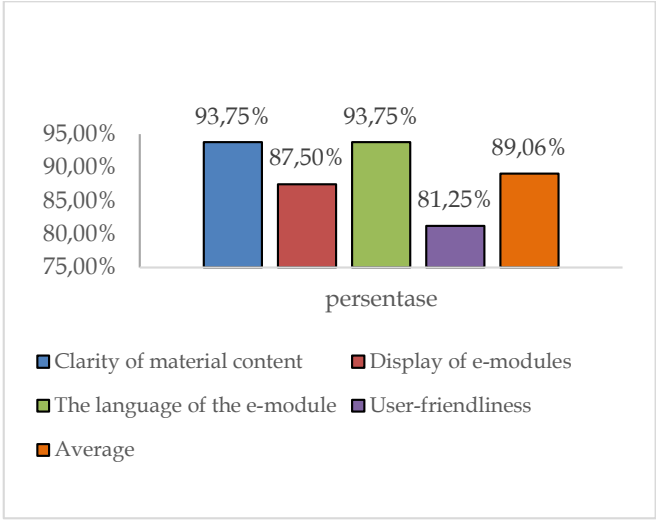

Figure 3. Practicality of e-modules

Figure 3 shows how practical the PBL based e-module product is according to teachers after implementing learning using e-modules. Overall, the e-module is very practical in all aspects except usefulness which only gets the practical category. In detail, the clarity of the material content and language of the e-module got a percentage of 93.75%, the appearance of the e-module got a percentage of 87.50%, and user usefulness was lower, namely 81.25%. In line with the research conducted Lestari et al. (2020) Teaching materials that have been tested for practicality are suitable for use in learning.

At the implementation stage, students' science process skills were also seen using the e-module being developed. When using e-modules to apply learning, two observers in the classroom complete observation sheets to assess each student's KPS. When the learning took place, there were six study groups so that one observer saw the KPS abilities of students in 3 groups. The following are the results of KPS observations during

the implementation of the PBL based e-module product that has been developed.

Table 2. Results of Student KPS Observations

Indicator	Groups 1, 2, and 3		Groups 4, 5, and 6	
	Ave-rage	Category	Ave-rage	Category
Have scientific thinking skills	90	Very suitable	80	Suitable
Solve problems in a scientific context	95	Very suitable	95	Very suitable
Communicating ideas and findings	85	Very suitable	85	Very suitable
Average	90	Very suitable	86.67	Very suitable

The average KPS observation results, namely groups 1, 2, and 3 with the very suitable category, received a score of 90. The average for groups 4, 5 and 6 was slightly lower, namely 86.67 with the very suitable category. The indicator of having scientific thinking skills in groups 1, 2, and 3 is in the very suitable category, but for groups 4, 5, and 6 it is only in the suitable category. Furthermore, the indicators for solving problems in a scientific context and communicating ideas and findings obtained a very suitable category for all class VII groups. Based on the findings of this KPS observation, it can be said that PBL-developed e-module goods can enhance students' science process skills. This is in accordance with research conducted by Marjanah et al. (2022) that using teaching materials in the form of modules can create effective learning to improve science process skills.

Evaluation Stage

Evaluation is the final working step of the ADDIE model used. Evaluation aims to assess the lesson material developed. In developing this PBL based e-module, researchers carried out two types of evaluation, namely formative evaluation and summative evaluation. Formative evaluation is carried out during the development process, such as checking the material in the e-module, adding videos or images that make the material easier for students to understand, and revising the design according to suggestions from validators. Meanwhile, summative evaluation measures students' level of success in understanding and applying the material taught. By conducting summative evaluations, researchers can ensure that the teaching objectives of improving students' science process skills have been achieved effectively and convincingly (Sugihartini & Yudiana, 2018). This is in accordance with Rumansyah et al. (2016) opinion that when the research goals and objectives are appropriate, the product can be implemented.

Conclusion

The ADDIE method has been used as a framework for designing PBL based e-modules which aim to encourage students' science process abilities. The results of validation tests by experts show that this e-module is qualitatively considered very feasible, with a proportion of 89.02% meeting the criteria as a very viable product. Apart from that, based on the teacher's assessment, this e-module is also considered very practical in its implementation in the classroom. Observations of students' science processing abilities while using PBL based e-modules indicate that all student groups benefit significantly from this product. These findings conclude that this PBL-based e-module can be applied effectively in the learning process to improve students' science process skills, so that students' learning becomes more meaningful and effective.

Acknowledgments

The researcher would like to thank all those who have helped, especially to SMPN 6 Yogyakarta who has given the opportunity to researchers to conduct research and implement this developed product.

Author Contributions

A. H and R. D: designed the research concept, research data analysis, article writing, e-module product editing, PBL based e-module product creation process, methodology design, as well as the coordination and execution of research activities. Meanwhile, the instruments used in the entire development research process have gone through the validation and evaluation stages, as well as editing carried out by S and I. W: with the collaboration of this team, the research was successfully carried out effectively and structured to achieve the stated objectives.

Funding

The researchers provided all funding for this study themselves; no outside support was received.

Conflicts of Interest

The authors declare no conflict of interest.

References

Adri, H. T., & Suwarjono. (2023). Developing Science E-Modules based on Scientific reasoning Skills for Primary Education Course. *Jurnal Penelitian Pendidikan IPA*, *9*(8). https://doi.org/10.29303/jppipa.v9i8.4727

Agung, I. D. G., Suardana, I. N., & Rapi, N. K. (2022). E-Modul IPA dengan Model STEM-PjBL Berorientasi Pendidikan Karakter untuk Meningkatkan Hasil Belajar Siswa. *Jurnal Imiah Pendidikan Dan Pembelajaran*, *6*(1). https://doi.org/10.23887/jipp.v6i1.42657

Anggraeni, N., Rahardjo, S. B., & Harlita, H. (2022). Validity of Problem Based Learning (PBL)-Based Global Warming E-Module. *Jurnal Penelitian Pendidikan IPA*, *8*(5). https://doi.org/10.29303/jppipa.v8i5.1934

Asrizal, A., Mardian, V., Novitra, F., & Festiyed, F. (2022). Physics electronic teaching material-integrated STEM education to promote 21st-century skills. *Cypriot Journal of Educational Sciences*, *17*(8). https://doi.org/10.18844/cjes.v17i8.7357

Astuti, A. D., Herdiyana, W., & Jailani, J. (2023). Pendekatan Saintifik dengan Berbasis Discovery Learning untuk Mendukung Kemampuan Communication, Critical Thinking, dan Pemecahan masalah. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *12*(1). https://doi.org/10.24127/ajpm.v12i1.6766

Cynthia, C., Arafah, K., & Palloan, P. (2023). Development of Interactive Physics E-Module to Improve Critical Thinking Skills. *Jurnal Penelitian Pendidikan IPA*, *9*(5). https://doi.org/10.29303/jppipa.v9i5.2302

Darmaji, Astalini, Rahayu, A., & Maison. (2018). Development Physics Practical Guided Based On Science Process Skill Using Problem Solving. *Edusains*, *10*(1). Retrieved from https://journal.uinjkt.ac.id/index.php/edusains/article/view/7248/pdf

Desyandri, D., Muhammadi, M., Mansurdin, M., & Fahmi, R. (2019). Development of integrated thematic teaching material used discovery learning model in grade V elementary school. *Jurnal Konseling Dan Pendidikan*, *7*(1). https://doi.org/10.29210/129400

Dewi, W. S., Siregar, R., Putra, A., & Hidayati, H. (2023). Effect of Problem-Based Learning Model on Students' Physics Problem Solving Ability: A Meta-Analysis. *Jurnal Penelitian Pendidikan IPA*, *9*(4). https://doi.org/10.29303/jppipa.v9i4.3291

Dogan, İ., & Kunt, H. (2016). Determination of Prospective Preschool Teachers' Science Process Skills. *Journal Of European Education*, *6*(1). https://doi.org/10.18656/jee.55973

Duda, H. J., Susilo, H., & Newcombe, P. (2019). Enhancing different ethnicity science process skills: Problem-based learning through practicum and authentic assessment. *International Journal of Instruction*, *12*(1). https://doi.org/10.29333/iji.2019.12177a

Evendi, E., & Verawati, N. N. S. P. (2021). Evaluation of Student Learning Outcomes in Problem-Based Learning: Study of Its Implementation and Reflection of Successful Factors. *Jurnal Penelitian Pendidikan IPA*, *7*(SpecialIssue). https://doi.org/10.29303/jppipa.v7ispecialissue.1099

Fredy, Lieung, K. W., Butarbutar, R., & Duli, A. (2019). Science process skills in learning environmental pollution using PBL models. *IOP Conference Series: Earth and Environmental Science*, *343*(1). https://doi.org/10.1088/1755-1315/343/1/012179

Hidayah, R., & Pujiastuti, P. (2016). Pengaruh PBL Terhadap Keterampilan Proses Sains dan Hasil Belajar Kognitif IPA pada Siswa SD. *Jurnal Prima Edukasia*, *4*(2). https://doi.org/10.21831/jpe.v4i2.7789

Kurniawan, D. A., Darmaji, D., Astalini, A., & Muslimatul Husna, S. (2023). Study of Critical Thinking Skills, Science Process Skills and Digital Literacy: Reviewed Based on the Gender. *Jurnal Penelitian Pendidikan IPA*, *9*(4). https://doi.org/10.29303/jppipa.v9i4.1644

Laksana, D. N. L., Seso, M. A., & Riwu, I. U. (2019). Content and Flores Cultural Context Based Thematic Electronic Learning Materials: Teachers and Students' Perception. *European Journal of Education Studies*, *5*(9). Retrieved from https://oapub.org/edu/index.php/ejes/article/view/2211

Lestari, N., Basri, K. I., Yusuf, S. M., Suciati, S., & Masykuri, M. (2020). Life skill integrated science-PBL module to improve critical thinking skills of secondary school students. *Universal Journal of Educational Research*, *8*(7). https://doi.org/10.13189/ujer.2020.080737

Maison, Darmaji, Astalini, Kurniawan, D. A., & Indrawati, P. S. (2019). Science process skills and motivation. *Humanities and Social Sciences Reviews*, *7*(5), 48–56. https://doi.org/10.18510/hssr.2019.756

Marjanah, M., Atmaja, T. H. W., Pandia, E. S., Nursamsu, N., & Manurung, N. (2022). Development of Biodiversity Practicum E-Module to improve Science Process Skills. *Jurnal Penelitian Pendidikan IPA*, *8*(4). https://doi.org/10.29303/jppipa.v8i4.1951

Mijaya, N. P. A. P., Sudiatmika, A. A. I. A. R., & Suardana, I. N. (2021). Pengembangan E-Modul Pembelajaran IPA SMP Kelas VII Berbasis Model Pembelajaran Levels Of Inquiry untuk

Meningkatkan Literasi Sains Siswa. *Quantum: Jurnal Inovasi Pendidikan Sains*, *12*(2). https://doi.org/10.20527/quantum.v12i2.11258

Moore, K. D. (2016). Effective instructional strategies: From theory to practice. Sage Publications. *Journal of Indian Education*, *42*(1). Retrieved from https://study.sagepub.com/moore4e

Nurfazliana, N., & Jumadi, J. (2023). Development of E-Module PBL Model Learning to Improve Students' Mastery of Concepts. *Jurnal Penelitian Pendidikan IPA*, *9*(5). https://doi.org/10.29303/jppipa.v9i5.3506

Nuri, L. N. N., Wahyuni, S., & Ridlo, Z. R. (2023). Development of an Android-Based Mobile Learning Module to Improve the Students Critical Thinking Skills. *Jurnal Penelitian Pendidikan IPA*, *9*(7). https://doi.org/10.29303/jppipa.v9i7.2944

OECD. (2019). *Programme for International Student Assessment (PISA) Result from PISA 2018*. OECD Publishing

Oktarina, R., Fitria, Y., Ahmad, S., & Zen, Z. (2023). Development of STEM-Oriented E-Modules to Improve Science Literacy Ability of Elementary School Students. *Jurnal Penelitian Pendidikan IPA*, *9*(7). https://doi.org/10.29303/jppipa.v9i7.4503

Redhana, I. W. (2019). Mengembangkan Keterampilan Abad Ke-21 Dalam Pembelajaran Kimia. *Jurnal Inovasi Pendidikan Kimia*, *13*(1). Retrieved from https://journal.unnes.ac.id/nju/index.php/JIPK/article/view/17824.

Rumansyah, Kosim, & Soeprianto, H. (2016). Pengembangan Model Pembelajaran Kooperatif Tipe Kosaji pada Pembelajaran Fisika. *Jurnal Penelitian Pendidikan IPA*, *2*(2). https://doi.org/10.29303/jppipa.v2i2.42

Siregar, F. M. H., Zainul, R., Andromeda, Oktavia, B., & Lubis, A. P. (2023). Module Development on Basic Laws of Chemistry Based on the 5E Instructional Model to Improve Science Process Skills in Senior High School. *Jurnal Penelitian Pendidikan IPA*, *9*(7). https://doi.org/10.29303/jppipa.v9i7.4343

Spatioti, A. G., Kazanidis, I., & Pange, J. (2022). A Comparative Study of the ADDIE Instructional Design Model in Distance Education. In *Information (Switzerland)* (Vol. 13, Issue 9). https://doi.org/10.3390/info13090402

Subarkah, C. Z., Alhak, A. A., Sari, S., Ruswandi, U., & Rochman, C. (2021). Developing E-module on the Topic of Integrated Addictive Substances with Islamic Values. *JTK (Jurnal Tadris Kimiya)*, *6*(1). https://doi.org/10.15575/jtk.v6i1.9802

Sueb, & Damayanti, J. (2021). The effect of macrozoobenthos diversity module based on problem-based learning on junior high school students' environmental attitudes. *Jurnal Pendidikan IPA Indonesia*, *10*(3). https://doi.org/10.15294/JPII.V10I3.30766

Sugihartini, N., & Yudiana, K. (2018). ADDIE Sebagai Model Pengembangan Media Instruksional Edukatif (MIE) Mata Kuliah Kurikulum dan Pengajaran. *Jurnal Pendidikan Teknologi Dan Kejuruan*, *15*(2). https://doi.org/10.23887/jptk-undiksha.v15i2.14892

Suryaneza, H., & Permanasari, A. (2016). Penerapan Pembelajaran IPA Terpadu Menggunakan Model Webbed Untuk Meningkatkan Literasi Sains Siswa. *EDUSAINS*, *8*(1). https://doi.org/10.15408/es.v8i1.1718

Syamsussabri, M., Suhadi, & Sueb. (2019). The Effect of Environmental Pollution Module on Environmental Worldview in Senior High School. *Journal of Physics: Conference Series*, *1417*(1). https://doi.org/10.1088/1742-6596/1417/1/012076

Usman, M. H., Al Idrus, A., Doyan, A., Soeprianto, H., & Hakim, A. (2021). Teacher Basic Skills in Learning Science in Junior High Schools Facing the 21st Century. *Jurnal Penelitian Pendidikan IPA*, *7*(3). https://doi.org/10.29303/jppipa.v7i3.652

Wulandari, S. I., Pamelasari, S. D., & Hardianti, R. D. (2023). Penggunaan E-Modul Berbasis Etnosains Materi Zat dan Perubahannya dalam Usaha Meningkatkan Kemampuan Berpikir Kritis Siswa SMP. *Proceeding Seminar Nasional IPA XIII*. Retrieved from https://proceeding.unnes.ac.id/index.php/snipa/article/view/2294

Yanuarni, R., Yuanita, P., & Maimunah, M. (2021). Pengembangan Perangkat Pembelajaran Model Problem Based Learning Terintegrasi Keterampilan Abad 21. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *10*(2). https://doi.org/10.24127/ajpm.v10i2.3331

Zulyati, Z., Sulastri, S., Nurmalia, C., Yusrizal, Y., & Hasan, H. (2022). Application of Problem-Based Worksheet on Hydrocarbon Combustion Materials through E-Learning to Enhance Student's Learning Outcomes and Enviromental Care Attitude. *Jurnal Penelitian Pendidikan IPA*, *8*(6). https://doi.org/10.29303/jppipa.v8i6.2055