Development of Natural and Social Science (IPAS) E-Modules Based on Project Based Learning to Improve The Collaboration Ability of Elementary School Students

Dwi Mahmud Rizki Riyanto*, Sekar Purbarini Kawuryan
Primary Education Department, Faculty of Education and Psychology,
Universitas Negeri Yogyakarta, Indonesia.
*Corresponding Author. Email: dwimahmud.2023@student.uny.ac.id

Abstract: This research aims to develop E-Modules of Natural and Social Sciences (IPAS) based on project-based learning to improve the collaboration skills of grade IV elementary school students that are feasible, practical, and effective. This research used a Research and Development (R&D) method with the ADDIE development model, which consists of five main stages: analysis, design, development, implementation, and evaluation. The subjects of this research were teachers and fourth-grade students in all primary schools in Tirtoadi, Mlati, Sleman, Yogyakarta. Observations, interviews, and questionnaires were used to collect data. The data analysis was qualitative and quantitative with an n-gain score test, independent t-test, and paired sample t-test. The results of research and development were in the form of IPAS e-module products based on project-based learning that are feasible, practical, and effective. The feasibility of the product from material experts and media experts obtained a percentage score of 88,71% with a very feasible category. The practicality of the product from the responses of educators and students obtained a percentage score of 81.58% with a very practical category. The effectiveness test results in an independent sample t-test showed a Sig. 0.022 < 0.05, and the paired sample t-test shows a Sig. 0.000 < 0.05. The results showed that the product was declared effective in improving the collaboration ability of grade IV elementary school students.

Introduction

The development of technology in the twenty-first century requires every individual to adjust to the situation to keep up with the times, including in the field of education. Technological literacy, human resource development, educational innovation, and the use of technology in the classroom are some of the primary areas of concentration for 21st-century education (Pangestu et al., 2024). Technology use in the classroom is one area that has long been a concern in education. Utilizing technology can distribute information so that students can respond to the learning process more easily (Triwahyuningtyas et al., 2022). In line with that, Fimansyah (2024) said that within the educational context, it's critical to comprehend the various functions of technology. Therefore, to raise the standard of education and make it more innovative and diverse, the education industry needs to adapt to technological advances and develop learning that is integrated with technology.

Entering 2024, most primary schools in Indonesia have implemented the Merdeka Curriculum in their learning. This curriculum has the principle of providing space for independence in learning for educators and students (Mustadi et al., 2024). One of the principles of the Merdeka Curriculum's implementation in Indonesia is the use of technology

in the classroom. In addition, one of the special features of this curriculum is the IPAS subject. When used, IPAS learning should provide information that is relevant to the environment and natural surroundings of students (Rohman et al., 2023). In IPAS lessons, in studying the environment, learners can see natural and social phenomena as interrelated (Wijayanti & Ekantini, 2023). With the breakthrough of IPAS lessons in the Merdeka Curriculum, IPAS is one of the subjects in the spotlight. Therefore, it needs to be well prepared for use in IPAS classes to maximize learning objectives.

Developing students into individuals who can adapt to changes in the twenty-first century is a problem facing educators today (Triwoelandari et al., 2023). Culture and Education Ministry publishes printed books as one of the learning resources used by educators to teach IPAS. However, the printed books used by students are limited in number and are only loaned to students (K. F. Pratiwi & Sulianto, 2023). This has an impact on learning that is less than optimal because one textbook is used by two to three students. In addition to books published by Kemendikbud, learning in primary schools uses books published by Erlangga and PT Jepe Press Media Utama (T. N. F. Putri et al., 2024). All three books focus on the 4C skills to support 21st century learners' abilities. Furthermore, the analysis of books published by Kemendikbud, Erlangga, and PT Jepe Press Media Utama shows that creativity skills are the most dominant aspect taught to students (T. N. F. Putri et al., 2024).

In implementing the Merdeka Curriculum, teachers can create lesson plans based on their own inventiveness and the traits of their students (Hehakaya & Pollatu, 2022). Digital modules, or e-modules, are among the advancements that educators can create in accordance with technological advances in the 21st century (Desyandri et al., 2024). E-modules are digital teaching materials designed to achieve specific goals and are developed with various navigation links to make them more interactive (Manzil et al., 2022). Another strategy to help implement twenty-first century education inside the classroom is the creation of digital teaching resources. Since educators play the role of facilitators in twenty-first century learning, the purpose of using digital modules in the classroom is to empower students to learn on their own without always being guided (Fahmi et al., 2020). Some recent research on e-module development still focuses on the learning content applied in the 2013 curriculum (Nurhayati, 2023; N. T. Putri et al., 2023). This is because the implementation of Merdeka Curriculum has not been implemented in Indonesia for a long time and some schools are still in the adaptation stage. Furthermore, the primary goal of using e-modules is to enhance student learning outcomes. (Agung et al., 2021; Nisrina et al., 2021).

The findings of the requirements analysis was out at four primary schools in the Yogyakarta region's Tirtoadi Mlati Sleman obtained data that the available IPAS teaching materials were very limited and the collaboration skills of grade IV students were low. Teaching materials are one of the learning tools used by educators to guide them in explaining the material to students. Researchers have the opportunity to create IPAS instructional resources in the form of electronic modules or digital modules because the field demonstrates that IPAS teaching materials are still limited because of the Merdeka Curriculum's recent implementation and educators' limited time to prepare teaching materials. By using e-modules in their learning, students can enhance their comprehension of concepts (Murod et al., 2021). If e-modules are created with students' needs and qualities in mind, they can help with learning. Therefore, in developing e-modules, it is necessary to consider the learning objectives and learning models that will be used within the classroom.

Learning modules can be developed using learning models. One of the learning models that most closely matches the traits of the twenty-first century is project-based

learning (PjBL). PjBL is one of the learning models that aims to train students to have the ability to think critically, creatively, actively collaborate, and communicate (Rafik et al., 2022). The PjBL model is an innovative learning model or approach that emphasises intellectual learning through complex activities (N. Pratiwi, 2021). PjBL belongs to innovative learning where the implementation is learner-centred and places education as a facilitator (Maharani & Nurharini, 2024). Recent studies on the application of PjBL in education have focused on critical thinking and creativity (Miftah et al., 2024; Winarti et al., 2022). Meanwhile, another skill that needs to be the focus of learning in the 21st century is collaboration. According to a study conducted in the United States, students who participate in PjBL also gain academic and non-academic skills like communication, teamwork, time management, and critical and creative thinking. (Revelle, 2019).

One of the most important abilities required to meet the challenges of the twenty-first century is collaboration. Kawuryan (2019) asserts that students must possess critical thinking, problem-solving, and teamwork abilities in the twenty-first century. One of the skills that must be familiarised by a person is the ability to collaborate (Kurniawati et al., 2020). The ability to collaborate is essential to improve the quality of work together. In IPAS lessons, the ability to collaborate is necessary for students to overcome challenges and learn successfully and efficiently. Collaboration abilities are necessary for students to approach difficulties with a spirit of respect, tolerance, accountability, and knowledge (Santoso et al., 2021). Collaboration also teaches learners to interact well with fellow learners and educators, appreciate differences, solve solutions, and develop empathy.

The findings of the study conducted by Nesri & Kristanto (2020) demonstrate how 21st-century skills, such as teamwork, can be developed using technology-assisted learning. Furthermore, Munazad (2023) also stated that one alternative that can help students develop their teamwork abilities is by using learning modules. The explanations above lead to the conclusion that four primary schools namely SD Negeri Kaweden, SD Negeri Pundong, SD Negeri Tirtoadi, and SD Negeri Gombang need an innovative teaching material in the form of a digital module to improve the collaboration skills of grade IV students. The purpose of this study was to create a feasible, practical, and efficient e-module that would help fourth-grade students become more proficient collaborators.

Research Method

This research used the research and development (R&D) method with the ADDIE model. Branch (2009) claimed that performance-based learning is built using the ADDIE approach. The ADDIE paradigm can be implemented in five phases: analyze, design, development, implementation, and evaluation. Here is the research flow that makes use of the model.
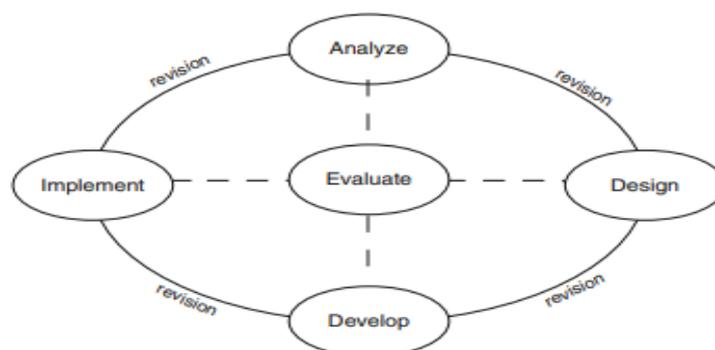

Figure 1. ADDIE Model Research Flow (Branch, 2009)

Three students and one SD Gombang teacher participated in the one-on-one trial phase, nine students and one SD Gombang teacher participated in the small group trial phase, and twenty-three students and one SD Pundong teacher participated in the field trial phase. Meanwhile, the implementation stage involved 44 fourth grade students of SD Tirtoadi and SD Kaweden which were separated into experimental and control classes. Observation guidelines, interview guidelines, validation of materials and media, questionnaires for teacher and student responses, and collaboration ability scales were the instruments used in this study. The data analysis used was qualitative and quantitative analysis with n-gain score test, independent sample t-test, and paired sample t-test.

Results and Discussion
Analyze

From interviews on the learning resources used by teachers - both teaching materials and media - the evidence shows that government-issued textbooks are the most common type of teaching materials used in classroom teaching. Meanwhile, the media used in IPAS learning is quite diverse ranging from contextual to utilizing digital technology. Furthermore, through interviews, it can also be seen that in preparing learning tools to be applied in the classroom, educators are constrained by time, other loads/tasks, and curriculum adaptation. Some educators mentioned that preparing innovative learning tools requires a relatively long time, so other alternative educators use tools that are already available, sometimes using additional tools from the internet.

Furthermore, initial analysis was also carried out through classroom observations. Based on observations conducted in four elementary schools, it was discovered that instructors utilized printed books produced through the Ministry of Culture and Education as their primary teaching resources when teaching IPAS in the classroom. The book becomes the teacher's handbook for delivering material to students. In addition, there is also one educator who uses teaching modules and PowerPoints as a variety of teaching materials in teaching material to students. Meanwhile, in IPAS learning, students also have printed books from the government. However, the limited number available is an obstacle for students to learn the material optimally. The limited number of books makes one book used by 2-3 students. Another alternative is that students use LKS to add to their reading material. It can be inferred from the findings of these observations and interviews that currently educators are still in the adaptation stage in implementing independent curriculum learning, so that the implementation is not optimal, they need additional learning tools in the form of digital teaching materials that are in accordance with technological developments. Teachers can modify the learning resources they use in class by using the digital teaching materials developed for IPAS learning. This is very much in accordance with the needs of educators because if they compile their learning tools, they are constrained by time and other burdens that are very difficult to fulfil.

Design

In the design stage, several important steps were taken to develop a project-based learning e-module product. Designing the content that will be included in the e-module is the first step. The IPAS material that is part of the e-module includes: my region and its natural resources, Indonesia's cultural wealth, and buying and selling activities as one way of fulfilling needs. In addition, the material content prepared with the PjBL model is focused on activities to improve students' collaboration skills with 5 indicators developed, namely: working productively, commitment to prioritizing group goals, having an attitude of responsibility, being able to control emotions, and participating in discussions and differences

of opinion. The five indicators will be used to determine the collaboration skills of grade IV students in IPAS subjects.

The e-module is the next phase layout using the Corel Draw and Canva applications. The e-module display is adjusted to the characteristics of grade IV elementary school students and is accompanied by several images, videos, and barcode links that can switch to interactive quizzes. Finishing the e-module is done by converting the pdf file into a heyzine flipbook so that students and teachers can access it anytime and anywhere using a laptop or smartphone connected to the internet. At this point, validator media will validate the product to offer evaluation and feedback as a foundation for future development.
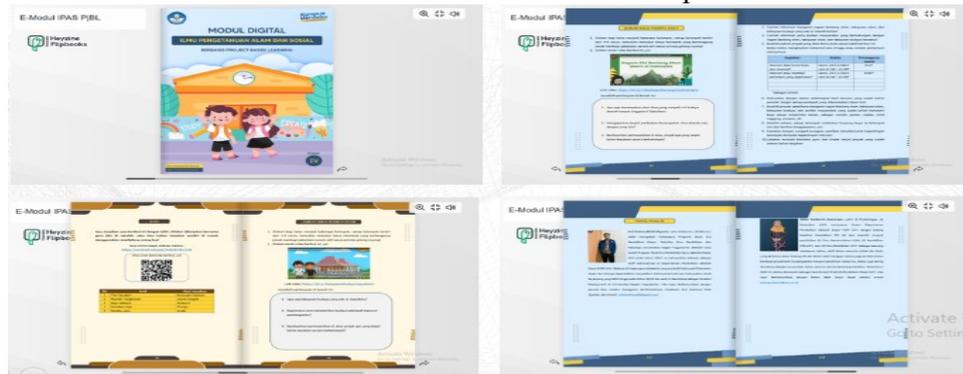

Figure 2. Product design of PjBL-based IPAS e-module

Development

After development, the e-module products are validated and trialled with students and teachers. There were three stages to the trial: one-to-one-trial, small group trial, and field trial. Validation was conducted to obtain an assessment of product feasibility, while the trial was conducted to determine the assessment of product practicality. The assessment results at the material and media validation stage showed very feasible results with the following scores.

Table 1. The findings of the validation evaluation by media and material experts

No	Type validation	Aspects	Score	Mean	Percentage	Predicate
1	Material	Material Content	62,5	4,77	95,5%	Very Decent
		Linguistics	33,5			
2	Media	Design	9			Very Decent
		Image	13,5			
		Layout	8	4,1	82%	
		Video	8			
		Features	11,5			
		Packaging	11,5			

The findings of the assessment conducted by media and material validators, who referred to the preset scoring guidelines, indicated that the media and material included in the developed IPAS e-module product fell into the "very feasible" category, allowing it to proceed to the following phase, which is product trials. At this point, the study was conducted three times using three different trial stages: one-to-one-trial, small group trial, and field trial. The following are the findings of the trial stage assessment.

Table 2. Practicality score results from teachers and students

No	Stage	Responden	Total	Mean (%)	Predicate
1.	*One-to-one-trial*	Students	3	83,1	Very practical
		Teacher	1	80	Practical

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2.	*Small group trial*	Students	9	71,96	Practical
		Teacher	1	91,11	Very practical
3.	*Field trial*	Students	23	81,2	Very practical
		Teacher	1	82,2	Very practical

Referring to the predetermined scoring guidelines, The findings of the instructors' and students' practicality assessment revealed that the IPAS e-module product developed was in the 'very practical' category so that it could be continued at the next stage, namely the implementation test.

Implementation

The implementation test in this study is one unit with the effectiveness test which is part of the implementation of the ADDIE model. At this stage, e-modules IPAS based on PjBL developed were applied in IPAS learning in grade IV. This research design uses a true experimental design with a pretest-post test control group design. The results of the pretest and posttest data are as follows.

Table 3. Results of Collaboration Skills Pretest and Posttest Data

No	Class	Mean		Gain	Criteria
		Pretest	**Posttest**		
1	Control	73,57	80,88	0.31	Medium
2	Experiment	79,88	90,44	0.58	Medium

The experimental class's pretest and posttest scores improved with a gain of 0.58. The gain score of 0.25 falls into the medium group according to the established standard gain category. The experimental and control groups' pretest and posttest results are further shown in the following diagram.
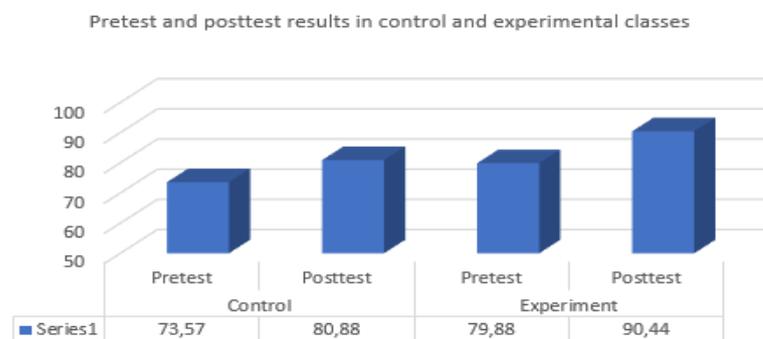

Pretest and posttest results in control and experimental classes

| ■ Series1 | 73,57 | 80,88 | 79,88 | 90,44 |

Figure 3. Pretest and posttest results for the experimental and control groups

The scale's data was then analyzed using paired samples and independent t-tests to see how well e-module products worked to help students become more collaborative. The independent t-test results in this study are based on the posttest results of the experimental and control classes' students' collaboration skills.

		Levene's Test for Equality of Variances				
		F	Sig.	t	df	Sig. (2-tailed)
Nilai	Equal variances assumed	2.924	.095	-2.371	42	.022
	Equal variances not assumed			-2.552	41.930	.014

Referring to the data that can be seen above, the results of the independent t-test on the student collaboration ability variable in the experimental and control classes resulted in a significance value of 0.022 or > 0.05 which indicates that Ha is accepted and H0 is rejected. Therefore, it can be said that students' collaboration skills in classes that use IPAS e-modules

for project-based learning are significantly different from classes that do not use IPAS e-modules. The results of the paired sample t-test are as follows.

Paired Samples Test

		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	95% Confidence Interval of the Difference Upper	t	df	Sig. (2-tailed)
Pair 1	PRETEST - POSTTEST	-10.556	8.053	1.898	-14.560	-6.551	-5.561	17	.000

Referring to the data that can be seen above, the paired sample t-test results on the student collaboration ability variable in the experimental and control classes resulted in a significance value of 0.000 or > 0.05 which indicates that Ha is accepted and H0 is rejected. Therefore, it can be said that students' collaboration skills in the class after using the IPAS e-module for project-based learning are significantly different from the class before that did not use the IPAS e-module..

Evaluation

Evaluation is the final phase of this research and development process. At this stage, the developed product is reviewed and improved according to the results of field trials and input suggestions that have been given. The final results obtained data that the IPAS e-module product based on project-based learning is very feasible, very practical, and effective to use to improve the collaboration skills of grade IV elementary school students. The developed e-module can be used for IPAS learning in grade IV.

Discussion

The e-modules created during this research and development process have been modified to address the impact of the curriculum policy, which combines social studies and science content into one lesson, IPAS (Zakarina et al., 2024). The material contained in the e-module is prepared based on the analysis of learning outcomes that have been carried out and the analysis of the characteristics of grade IV students. In line with this, Bararah (2017) stated that learning will be more optimized and concentrated when resources are in line with curriculum requirements. The e-module product developed in this study was designed for grade IV elementary school students. In the design aspect, the assessment by media experts focuses on the accuracy and attractiveness of the design. Irkhamni (2021) stated that one of the assessments of learning quality can be seen from the attractiveness of the design and appearance which is arranged systematically. Furthermore, one of the uniqueness of the developed e-module is that it is equipped with a scan/barcode that can switch to an interactive quiz or video (Awwalina et al., 2022).

PjBL is a model that can help learners develop their collaboration skills through making quality products (Triwoelandari et al., 2023). Collaboration skills can be trained through cooperation between group members when working on certain tasks. The features available in the e-module not only make it easier for learners to access the material but also connect learners directly to discuss and share thoughts. In line with that, Mawaddah (2022) shows that learners can discuss ideas and exchange viewpoints so that collaboration skills can be trained. Students can improve their collaboration and communication abilities as a result.

The PjBL-based IPAS e-module product in this study received a significant value of 0.022, or < 0.05, on the variable collaboration capacity of students in the experimental and control courses, indicating that Ha is accepted and H0 is rejected. Consequently, it may be said that there is a notable variation in the capacity for collaboration of students between classes that use project-based learning-based IPAS e-modules and those that do not use them.

These findings are consistent with studies carried out by Alfaeni (2022) which show how project-based learning can improve students' ability to collaborate. Furthermore, the PjBL model can encourage interaction between learners so that collaboration skills are more honed. (Lu, 2023).

This study showed that the development of the IPAS e-module is in compliance with current curriculum guidelines, which combine social studies and science into IPAS. This also strengthens the concept that PjBL can increase the relevance of the material to students' real life. Additionally, in order to construct the e-module in compliance with the peculiarities of fourth-grade elementary school kids, the demands of the pupils are analyzed. According to the twenty-first century's developments, the e-module is equipped with a scan/barcode which shows the implication that there is technology integration that can facilitate student learning interactivity. IPAS e-modules, which are based on PjBL learning, can be used by teachers as a learning tool to bring diversity to classroom contents, particularly to enhance students' ability to collaborate. In addition, through the tasks offered, the designed e-module gives teachers the chance to teach pupils how to collaborate, as well as to improve students' collaboration skills according to the specified indicators.

Conclusion

Project-based learning-based IPAS e-module products are the end product of research and development, and they are feasible, practical, and effective. The feasibility of the product from material experts and media experts obtained a percentage score of 88.71% with a very feasible category. The practicality of the product from the responses of educators and students obtained a percentage score of 81.58% with a very practical category. The results of the effectiveness test in the form of an independent sample t-test showed a Sig. 0.022 <0.05, paired sample t-test showed a Sig. 0.000 <0.05. These findings demonstrate how well the product works to help fourth graders become more collaborative.

Recommendation

The developed IPAS e-module can be used as a companion to existing IPAS teaching materials. With a simple concept, this e-module is an example of developing innovative and interesting digital learning tools, and can be used independently by learners from home, making it an ideal option for online learning. Furthermore, the research results can be the first step for other researchers to improve, enhance, and perfect all the shortcomings and limitations that exist.

References

Agung, I. D. G., Suardana, N., & Rapi, N. K. (2021). 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

Alfaeni, D., Nurkanti, M., & Halimah, M. (2022). Kemampuan Kolaborasi Siswa melalui Model Project Based Learning Menggunakan Zoom pada Materi Ekosistem. *BIOEDUKASI: Jurnal Pendidikan Biologi*, *13*(2), 143–149. https://doi.org/http://dx.doi.org/10.24127/bioedukasi.v13i2.6330

Awwalina, N. M., Biologi, P., Matematika, F., Ilmu, D., & Alam, P. (2022). Development of QR Code Based Interactive E-module to Train Class X High School Student's Science Literacy Skills in Ecosystem Topic. *Berkala Ilmiah Pendidikan Biologi*

(BioEdu), *11*(3), 712–721. https://doi.org/https://doi.org/10.26740/bioedu.v11n3.p712-721

Bararah, I. (2017). Efektifitas Perencanaan Pembelajaran dalam Pembelajaran Pendidikan Agama Islam di Sekolah. *Jurnal MUDARRISUNA*, *7*(1), 131–147.

Branch, R. M. (2009). Instructional design: The ADDIE approach. In *Instructional Design: The ADDIE Approach*. Springer US. https://doi.org/10.1007/978-0-387-09506-6

Desyandri, Agustina, Y., & Lusiana, D. (2024). The Development of Problem-Based Learning Model E-Module Integrated with Multiculturalism in Elementary Schools. *Jurnal Prima Edukasia*, *12*(2), 183–193. https://doi.org/10.21831/jpe.v12i2.62368

Fahmi, R., Tusa', H., Aswirna, P., & Sabri, A. (2020). Pengembangan Keterampilan Kolaborasi Melalui Penerapan Modul Interaktif Berbasis TTI. *Natural Science: Jurnal Penelitian Bidang IPA Dan Pendidikan IPA*, *6*(2), 197–210. https://doi.org/10.15548/nsc.v6i2.1932

Firmansyah, Tafakur, Destiana, B., & Sandra Dewi, A. (2024). Defining Technology-Based Learning Media in Science Subjects for Elementary Schools. *Jurnal Prima Edukasia*, *12*(2), 242–252. https://doi.org/10.21831/jpe.v12i2.71824

Hehakaya, E., & Pollatu, D. (2022). Problematika Guru Dalam Mengimplementasikan Kurikulum Merdeka. *DIDAXEI*, *3*(2), 394–408.

Irkhamni, I., Zulfa Izza, A., Salsabila, W. T., & Hidayah, N. (2021). Pemanfaatan Canva sebagai E-Modul Pembelajaran Matematika terhadap Minat Belajar Peserta Didik. *Prosiding Konferensi Ilmiah Pendidikan*. https://proceeding.unikal.ac.id/index.php/kip

Kawuryan, S. P. (2019). Relevansi Konsep Pemikiran Pendidikan dan Kebudayaan George S. Counts dan Ki Hajar Dewantara dengan Kompetensi Peserta Didik Abad 21. *Jurnal Civics: Media Kajian Kewarganegaraan*, *16*(2), 175–186. https://doi.org/10.21831/jc.v16i2.22045

Kurniawati, H. A., Rossalina Erriska, R., & Prasetyo, Z. K. (2020). Development of POE and SETS Based Science E-Module to Facilitate Creative Thinking Skill and Collaboration Skill. *International Conference on Educational Research and Innovation (ICERI 2019)*, 122–126.

Lu, H. F. (2023). Statistical learning in sports education: A case study on improving quantitative analysis skills through project-based learning. *Journal of Hospitality, Leisure, Sport and Tourism Education*, *32*. https://doi.org/10.1016/j.jhlste.2023.100417

Maharani, M. D., & Nurharini, A. (2024). The Relationship Between the Use of TikTok and PjBL Models with Music Learning Outcomes. *Jurnal Prima Edukasia*, *12*(2), 272–283. https://doi.org/10.21831/jpe.v12i2.74246

Manzil, E. F., Sukamti, & Thohir, M. A. (2022). Pengembangan E-Modul Interaktif Heyzine Flipbook Berbasis Scientific Materi Siklus Air bagi Siswa Kelas V Sekolah Dasar. *Sekolah Dasar: Kajian Teori Dan Praktik Pendidikan*, *31*(2), 112–126. https://doi.org/http://dx.doi.org/10.17977/um009v31i22022p112

Mawaddah, R., Triwoelandari, R., & Irfani, F. (2022). Kelayakan LKS Pembelajaran IPA Berbasis STEM untuk Meningkatkan Keterampilan Kolaborasi Siswa SD/MI. *Jurnal*

Cakrawala Pendas, *8*(1), 1–14. https://doi.org/http://dx.doi.org/10.31949/jcp.v8i1.3338

Miftah, N. A., Hanifah, N., & Gustian Nugraha, R. (2024). Penerapan Project Based Learning pada Tema 3 Benda di Sekitarku untuk Meningkatkan Kreativitas dan Hasil Belajar Kelas III SD Negeri 4 Cindaga. *Didaktika: Jurnal Kependidikan*, *13*(1), 219–230. https://doi.org/https://doi.org/10.58230/27454312.470

Munazad, L., Hafizah, E., & Sauqina. (2023). Pengembangan Modul Pembelajaran IPA Berbasis ICARE untuk Memfasilitasi Keterampilan Kolaborasi Siswa SMP/MTs. *Journal on Teacher Education*, *5*(1), 19–28. https://doi.org/https://doi.org/10.31004/jote.v5i1.15491

Murod, M., Utomo, S., & Utaminingsih, S. (2021). Efektivitas Bahan Ajar E-Modul Interaktif Berbasis Android untuk Peningkatan Pemahaman Konsep Lingkaran Kelas VI SD. *FENOMENA*, *20*(2), 219–232. https://doi.org/10.35719/fenomena

Mustadi, A., Wibowo, S. E., Zubaidah, E., Supartinah, S., Sugiarsih, S., & Sayekti, O. M. (2024). Needs Analysis of Project Based Teaching Module Development in the Independent Curriculum. *Jurnal Prima Edukasia*, *12*(1), 52–60. https://doi.org/10.21831/jpe.v12i1.66933

Nesri, F. D. P., & Kristanto, Y. D. (2020). Pengembangan Modul Ajar Berbantuan Teknologi untuk Mengembangkan Kecakapan Abad 21 Siswa. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *9*(3), 480. https://doi.org/10.24127/ajpm.v9i3.2925

Nisrina, S. H., Rokhmawati, R. I., & Afirianto, T. (2021). Pengembangan E-modul Berbasis Project Based Learning (PjBL) pada Mata Pelajaran Animasi 2 Dimensi dan 3 Dimensi untuk Meningkatkan Hasil Belajar Peserta Didik. *Edu Komputika Journal*, *8*(2), 82–90. https://doi.org/https://doi.org/10.15294/edukomputika.v8i2.48451

Nurhayati, N. (2023). Pengembangan E-Modul Asam Basa Model Project Based Learning (PjBL) Terintegrasi Science, Technology, Engineering, Art, And Mathematics (STEAM) pada Peserta Didik SMKN 9 Bulukumba. *Chemistry Education Review*, *6*(2), 2597. https://doi.org/10.26858/cer.v6i2.13315

Pangestu, K., Malagola, Y., Robbaniyah, I., & Rahajeng, D. (2024). The Influence of Project Based Learning on Learning Outcomes, Creativity and Student Motivation in Science Learning at Elementary Schools. *Jurnal Prima Edukasia*, *12*(2), 194–203. https://doi.org/10.21831/jpe.v12i2.63208

Pratiwi, K. F., & Sulianto, J. (2023). Pengembangan E-Modul Berbasis Project Based Learning untuk Meningkatkan Kemampuan Berpikir Kritis Siswa Kelas IV Sekolah Dasar. *Didaktik : Jurnal Ilmiah PGSD STKIP Subang*, *9*(4), 1282–1294. https://doi.org/https://doi.org/10.36989/didaktik.v9i04.1718

Pratiwi, N. (2021). The effect of PjBL Model toward PGSD student's ability in conducting research of natural science. *Jurnal Prima Edukasia*, *9*(2). https://doi.org/10.21831/jpe.v9i2.33695

Putri, N. T., Ariyani, F., & Adha, M. M. (2023). Pengembangan E-Modul Bermuatan Tema Cita-Citaku Berbasis Project Based Learning. *Al-Madrasah: Jurnal Pendidikan Madrasah Ibtidaiyah*, *7*(3), 964. https://doi.org/10.35931/am.v7i3.2339

Putri, T. N. F., Untari, E., & Utama, C. (2024). Analisis Muatan 4C dalam Buku IPAS Kelas IV Sekolah Dasar Kurikulum Merdeka. *Jurnal Inovasi Pendidikan Nusantara*, *1*(1), 1–9. https://e-jurnal.mediainsancreative.org/index.php/ipnu

Rafik, M., Vini Putri Febrianti, Afifah Nurhasanah, & Siti Nurdianti Muhajir. (2022). Telaah Literatur: Pengaruh Model Pembelajaran Project Based Learning (PjBL) terhadap Kreativitas Siswa Guna Mendukung Pembelajaran Abad 21. *Jurnal Pembelajaran Inovatif*, *5*(1), 80–85. https://doi.org/10.21009/jpi.051.10

Revelle, K. Z. (2019). Teacher perceptions of a project-based approach to social studies and literacy instruction. *Teaching and Teacher Education*, *84*, 95–105. https://doi.org/10.1016/j.tate.2019.04.016

Rohman, A. D., Hanifah, H., & Ghany Hayudina, H. (2023). Penggunaan Media Kartu Transformasi Energi pada Mata Pelajaran IPAS dalam Meningkatkan Sikap Berpikir Kritis Siswa Kelas IV MII Degayu 02 Pekalongan. *Prosiding SEMAI 2. Seminar Nasional PGMI* , 35–43. http://proceeding.uingusdur.ac.id/index.php/semai

Santoso, A. M., Primandiri, P. R., Zubaidah, S., & Amin, M. (2021). Improving student collaboration and critical thinking skills through ASICC model learning. *Journal of Physics: Conference Series*, *1806*(1). https://doi.org/10.1088/1742-6596/1806/1/012174

Triwahyuningtyas, D., Setiawan, O. Y., & Mahmuda, N. E. (2022). E-Module of Cube and Beam Based on Inquiry for Five Grade Students of Elementary School. *Jurnal Prima Edukasia*, *10*(2), 138–148. https://doi.org/10.21831/jpe.v10i2.48194

Triwoelandari, R., Rahmawati, P., & Gustiawati, S. (2023). Pengembangan Modul Pembelajaran IPA Berbasis Project Based Learning untuk Meningkatkan Kemampuan Kolaborasi Siswa Kelas 5 SD/MI. *Attadib: Journal of Elementary Education*, *7*(3). https://doi.org/https://doi.org/10.32507/attadib.v7i2.2298

Wijayanti, I. D., & Ekantini, A. (2023). Pendas: Jurnal Ilmiah Pendidikan Dasar. *Pendas: Jurnal Ilmiah Pendidikan Dasar*, *8*(2), 2100–2112. https://doi.org/https://doi.org/10.23969/jp.v8i2.9597

Winarti, N., Hamdani Maula, L., Rizqia Amalia, A., & Liany Ariesta Pratiwi, N. (2022). Penerapan Model Pembelajaran Project Based Learning untuk Meningkatkan Kemampuan Berpikir Kritis Siswa Kelas III Sekolah Dasar. *Jurnal Cakrawala Pendas*, *8*(3). https://doi.org/10.31949/jcp.v8i2.2419

Zakarina, U., Ramadya, A. D., Sudai, R., & Pattipeillohi, A. (2024). Integrasi Mata Pelajaran IPA dan IPS dalam Kurikulum Merdeka dalam Upaya Penguatan Literasi Sains dan Sosial di Sekolah Dasar. *Damhil Education Journal*, *4*(1), 50–56. https://doi.org/http://dx.doi.org/10.37905/dej.v4i1.2487