JPPIPA 10(7) (2024)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

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

Development of IPAS on Matter and its Changes Based on PjBL to Improve the Science Process Skills for Grade E Vocational High School

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Received: May 28, 2024
Revised: June 19, 2024
Accepted: July 25, 2024
Published: July 31, 2024

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DOI: 10.29303/jppipa.v10i7.7801

Abstract: The aim study to produce module of IPAS learning based on project based learning to improve the science process skill for grade E SMK and to determine level of validity practicality and effectiveness. The type of research used research and development (R&D). The development model used 4D models (define, design, development and dessiminate). The module of IPAS learning was validated by three chemistry lecturers from FMIPA UNP and two chemistry teachers from SMK Swasta Bakti Agro Mandiri and SMKN 1 Kempas. Determination of the practicality level of module IPAS learning by two chemistry teachers from SMK Swasta Bakti Agro Mandiri and SMKN 1 Kempas and 30 students of grade E SMK Swasta Bakti Agro Mandiri. The results of the practicality analysis based on teacher and student response questionnaires obtained Aiken scores of 0.97 and 0.93 respectively in the very high practicality category. Therefore, it can be said that the module based on project based learning to improve the science process skill for grade E SMK on matter and its change material is valid, practicable, and effective.

Keywords: Matter and its change project based learning; Module; Science process skills

Introduction

In the 21st Century, there are many skills that must be developed in students, in order to increase cognitive skills and levels of critical thinking and creativity (Alhayat et al., 2023). The implementation of the Independent Curriculum (IKM) has been implemented since 2021 by several schools, albeit in stages, and in the 2022 school year, the implementation of the independent curriculum will begin to be evenly distributed, starting at the PAUD, SD/MI levels, Phase A, class I and class II, Phase B, class III and IV. , Phase C classes V and VI. For junior high school level, Phase D is for class VII, class VIII, and class IX (Umami et al., 2021).

There has been a lot of research that examines project-based learning in creating modules. However, each has its own characteristic needs. Based on previous studies, there has been no research regarding science-based project-based learning modules to improve science process skills.

Research by Natalia (2023) with the title "Development of a Project-Based Science and Science Module to Increase the Learning Creativity of Vocational School Students". Based on the research that has been carried out, the results show that the module developed increases the learning creativity of students.

Moreover research conducted by Mahjatia et al. (2021) with title "Development of STEM-based LKPD to train students science process skills through guided inquiry". Based on the research that has been carried out, the results show that the LKPD developed trains the science process skills of class XI MIPA students.

Research conducted by Nurdiansah et al. (2021) with title "Effectiveness of Laboratory-Based Hybrid Project Based Learning (H-Pjbl) Modules for Improving Students' Science Process Skills", based on the results of

How to Cite:
Novianti, E. R., & Hardeli. (2024). Development of IPAS on Matter and its Changes Based on PjBL to Improve the Science Process Skills for Grade E Vocational High School. *Jurnal Penelitian Pendidikan IPA*, *10*(7), 4066–4074. https://doi.org/10.29303/jppipa.v10i7.7801

this research, laboratory-based H-PjBL modules can improve science process skills Class X SMK student majoring in TKRO.

Meanwhile, this research focuses more on the development of IPAS's modules on matter and its changes based on Project Based Learning to improve the science process skills for grade E Vocational High School. Departing from the crucial importance of the current independent curriculum, it certainly places demands on teachers to continue to be able to develop and implement teaching material content which of course must be relevant to the changing demands of today's times (Rahayu et al., 2023)

Vocational High School (SMK) is a level of formal education that is becoming increasingly popular with students because the learning process provides various practices and exercises in each skills program. Vocational school graduates are directed as graduates who are ready to work according to their competencies in their field of interest, are able to become entrepreneurs and continue their education, are competitive, and have strong character as professionals' workers who are really needed in the world of work. Not only that, scientific process skills involve a series of logical steps that must be followed to obtain data, analyze it, and draw conclusions based on existing evidence (Zekri et al., 2020)

The Natural and Social Sciences Project (IPAS) to equip students to be able to solve real-life problems in the 21st century related to natural and social phenomena in their surroundings scientifically by applying scientific concepts (Adiyanto et al., 2024). Project Based Learning (PjBL) is an innovative learning model, which emphasizes contextual learning through complex activities. In project-based learning, students are encouraged to be more active, teachers provide convenience and evaluate both its meaningfulness and application in everyday life (Hayat et al., 2023). One of the skills that can be developed through the PjBL learning model is science process skills (KPS) (Natalia, 2023).

Regarding improving the quality of vocational education in the era of the fourth industrial revolution, educators must understand the means, strategies and teaching materials used for learning in order to fulfill learning (Rahmanto et al., 2024). A module is a tool or set of learning media in which various aspects are prepared as well as possible so that you get the desired abilities (Isma et al., 2023)

Project-based learning is a learning approach that gives students the freedom to plan learning activities, carry out projects collaboratively, and ultimately produce work products that can be presented to others (Masaguni et al., 2023). According to Natalia (2023) learning modules can be packaged in such a way that they can be used at any time. It contains a set of lessons that are planned and designed to help students master specific learning objectives. Based on the theory, modules integrated with science process skills will be increase and improve learning outcomes of students.

Science process skills are skills that involve all students' abilities in acquiring knowledge based on phenomena. The students' abilities in question are the skills of observing, grouping, interpreting, predicting, asking questions, hypothesizing, planning experiments, applying concepts, communicating and carrying out experiments (Ismail, 2023). Science process skills involve a series of logical steps that must be followed to obtain data, analyze it, and draw conclusions based on existing evidence (Senisum, 2021).

Method

The type of research used is research and development (R&D). This type of research was taken based on the research objectives taken, namely to produce and determine the level of feasibility of the module. Research and Development (R&D) research methods are used to produce a product and test its level of effectiveness Research design and method should be clearly defined (Sugiyono, 2019).

The development model used in this research is the 4-D model (Four D Models) which was developed by Thiagarajan (1974). This 4-D model consists of four development stages, define, design, develop and disseminate (Trianto, 2011).

The subjects of this research were three lecturers in the Chemistry Department, FMIPA UNP, IPAS's teacher and students of SMK Grade E SMKS Bakti Agro Mandiri. The research design used in testing research products is the field trial design carried out is Quasi Experimental Design. Quasi experimental design uses two sample groups, one sample group acts as the treatment and the other group acts as the control group (Sugiyono, 2017).

Some aspects of validation conducted include validation of content, presentation, language and graphics. Then aspect of practicality is ease of use, time efficiency and benefits (Boslaugh, 2008). The data collection techniques used in this research include observation, interviews, questionnaires, documentation, and posttest and pretest questions. Posttest and pretest questions are provided to determine the effectiveness level of the learning module in student learning outcomes (Arikunto, 2015).

The analysis technique for assessing the feasibility of the learning module uses a Aiken's Value (Aiken, 1985). Respondent answers are scored on a scale where very goodis assigned a weight of 5 points, goodis assigned 4 points, fairis assigned 3 points, pooris

assigned 2 points, and very poor is assigned 1 point. Practicality and validity analysis was carried out using equation 1 (Aiken, 1985).

$$V = \frac{\Sigma s}{n(c-1)} \quad (1)$$

Information:

s : $r - I_o$

r : The value given by the validator

I_o : Low validity value

n : Number of expert validators

c : highest validity score

Effectiveness testing is carried out by comparing conditionsbefore and after using the learning module. Normality testing is conducted to assess the distribution of data for a variable, determining whether the data distribution is normal or not. The technique used is the Liliefors normality test, and the developed module then undergoes the Paired T-test analysis technique (Nuryadi, 2017).

Result and Discussion

The results of module of IPAS learning based on project based learning to improve the science process skill for grade E SMK are as following below:

Define Analysis

The purpose of this front end analysis is to surface the basic problems faced by teachers and students on IPAS learning, especially the matter and its change. Which is observed in three school of Indragiri Hilir, Riau include SMKN 1 Tembilahan Hulu, SMKN 1 Kempas and SMKS Bakti Agro Mandiri their students wonts a modules of IPAS on matter and its change for their major Agribusiness Plantation.

So therefore results obtained from this definition stage were that problems were found that required the development of science learning modules. The IPAS module was developed in the form of print media. Based on research from Witri et al. (2023) learning modules can improve students' learning outcomes and science process skills.

According to Zaputra et al. (2021) too modules are one of the learning media that students can use as a learning resource.

Design Analysis

The IPAS module was designed using Microsoft Word 2010 with a combination of pastel blue colors and other supporting images that are synchronized with the major of Agribusiness Plantation.

The module cover section is in accordance with the 2017 module preparation guidelines from the Ministry of Education and Culture, namely that the cover as the identity of the module must contain the title of the module, subject name, topic/learning material, class, author and school logo. The cover is designed with attractive colors so that it arouses students' interest in reading and studying it (Arista et al., 2022).

The cover is designed in pastel blue combined with gray with the aim of giving a calming impression so that it can make readers feel calm while reading. So it is hoped that students will feel relaxed and calm when learning using the module. The module cover design can be seen in Figure 1.

Figure 1. Cover of modules

Cover also contains images with major of Agribusiness Plantation. The supporting images used are images of oil palm plantations, chemical fertilizers, aluminum, and several other images related to one substance and change.

The module consists of practice questions on each material presented. Practice questions aim to test the achievement of learning objectives. By having questions in the form of descriptive questions, it is hoped that students will be able to strengthen the concepts they

have learned. The display of the practice questions can be seen in Figure 2.

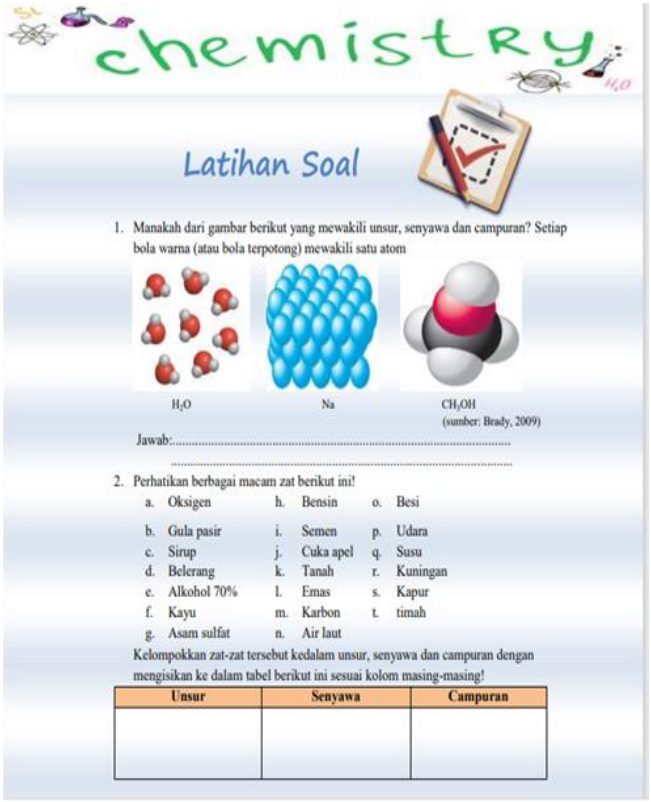

Figure 2. Exercises of modules

Develop Analysis

Module validity data is obtained from expert review using validated instruments. There are at least three expert reviewers to test the validity of the product (Sugiyono, 2019).

Validity Test

According to Asri et al. (2022) there are four parts to assessing the validity of the module, including content, language, presentation and graphic components.

Table 1. Results of Validation Data Analysis of the IPAS Module by the Validator

Rated aspect	Aiken's V	Validity Category
materials	0.87	Valid
language	0.94	Valid
presentations	0.97	Valid
graphics	0.88	Valid
Mean of V	0.92	Valid

Based on the statements in each item table 1, both material experts stated modules of IPAS learning received a score of 0.92, which is declared valid and suitable in terms of material. This is in accordance with the theory that content validity shows that the product developed is consistent with the curriculum and learning (Baidlok et al., 2020).

In the linguistic assessment, the IPAS module developed is related to literacy in explaining substances and their changes. Based on the validity results from the validator listed in table 1, the Aiken's V value was 0.94 in the valid category. The Aikens' V value of 0.94 shows that module IPAS based on project based learning was developed using good and correct Indonesian language rules and is easy to understand, the shape and size of the letters are clearly legible, the instructions and information conveyed in the module are clearly legible.

According to Umami et al. (2021) a good module states that it is friendly to use, the module must use simple language, be easy to understand, and include common terms. In the assessment of the presentation of the project-based learning-based IPAS module, it received an Aiken's V validity value of 0.97 with the valid category listed in table 1. The IPAS module developed was declared valid because instructions for using the module were available, practice question sheets were available for students, worksheets were available. practice in the activities of making liquid organic fertilizer and eco enzymes and in the module there are evaluation questions and answer keys (Zaputra et al., 2021).

The IPAS module developed is also in accordance with the project based learning syntax which consists of determining basic questions, preparing project plans, preparing project schedules, monitoring projects, testing results and presentations as well as evaluating and reflecting on experiences. According to Siswati et al. (2024) project based learning modules can increase students' creativity, science process skills and make students more communicative in conveying their opinions.

In the graphic assessment listed in table 1, the Aiken's V value was 0.88 in the valid category. The project-based learning-based science and science module developed has an orderly layout, the type of writing and letters used are clearly legible, the images supporting the material can be seen clearly, the module cover design is in accordance with the material, substances and changes. The IPAS module developed as a whole is attractive with an average value of Aiken's V validity from all validators of 0.92 and can be declared valid. According to Depdiknas (2008), that a module must include graphics to make it easier for students to understand the content provided.

Practicality Test

Practicality is a measure used to determine the ease of use of a user-created product. The level of usefulness of a product can be measured from the ease of

presentation by users. The practicality test is based on responses from teacher and students.

Table 2. Results of Practicality Data Analysis of the IPAS Module by Teachers

Rated aspect	Aiken's V	Practicality Category
ease of use	0.92	Practical
time efficiency	1.00	Practical
benefits	0.98	Practical
Mean of V	0.93	0.97

Practicality of use is related to the cost and time to carry out learning using teaching materials, as well as processing and interpreting the results (Faizin et al., 2023).

Table 3. Results of Practicality Data Analysis of the IPAS Module by Students

Rated aspect	Aiken's V	Practicality Category
ease of use	0.93	practical
time efficiency	0.93	practical
Benefits	0.92	practical
Mean of V	0.93	practical

Based on the statements in each aspect table 2, modules of IPAS learning received a score of 0.97, which is declared practical and approve by teacher. The practicality of module based on matter and its changes, for the ease of use indicator, received Aiken's V scores from teachers and students respectively of 0.92 and 0.93 with a very high level of practicality. This shows that the IPAS module developed meets one characteristic of practical media, namely ease of use.

The practicality of the IPAS module based on project based learning on matter and its changes to the aspect of time efficiency obtained the Aiken's V value from filling out the teacher and student questionnaires respectively was 1.00 and 0.93 in the very practical category. The IPAS module can make learning time more efficient, students can also learn according to their speed or abilities. According to Pamorti et al. (2024) the main aim of making modules is to increase the efficiency and effectiveness of learning, both in terms of time, facility resources and energy, so that the objectives can be achieved optimally.

The practicality of module based on project based learning on matter and its changes regarding the benefits of using the module obtained by Aiken's V from filling out teacher and student questionnaires was 0.98 and 0.92 respectively with a very practical level of practicality. The module of IPAS developed for teachers can support the their role as a facilitator, slightly reduce the teacher's workload in explaining the material repeatedly and can help students understand the concept of the material (Aisyaha, 2023).

Not only that, the module can also help students improve their science process skills. According to (Majid et al. (2014), the practicality of learning materials is expressed when teachers and students can easily use these materials in the teaching and learning process. Based on the statements in each aspect, modules of IPAS learning received a score of 0.93, which is declared practical and approve by students.

Disseminate Analysis

The effectiveness of the developed IPAS's module is evaluated based on the comparison of pretest and posttest results of students using the module. As seen in the table the normality test analysis using liliefors table at a significance level of 5% shows that the data results are normally distributed in the comparison of pretest and posttest results (Fajri et al., 2022).

The normality test by the Liliefors test is carried out by comparing the L_0 and L_{table} values which are determined at a significance level of 0.05 and n (number of data) = 15. The result of normality test can be seen in table 4. The result of that experiment class and control class is $L_0<L_{tab}$ its mean normal.

Table 4. Normality Test

Class	N	α	L_0	L_{table}	Analysis	Description
Experiment	15	0.05	0.197	0.220	$L_0<L_{tab}$	Normal
Control	15	0.05	0.169	0.220	$L_0<L_{tab}$	Normal

The paired sample T-test is used to compare two means from two paired samples with data that has been normally distributed. The paired samples are derived from the same subjects and taken in different situations, such as before and after using the learning modules.

Table 5. T-test

Class	N	α	t_{count}	t_{table}
Experiment	15		6.67	
Control	15	0.05		2.05

From the data processing that has been carried out, t count is 6.67 and t table is 2.05. The hypothesis criteria are accepted at a significance level of 0.05 with a value of t count > t table. From the final test results, it was found that the value of t count > t table at a significance level of 0.05, meaning that H_0 was rejected and H_1 was accepted. This shows that the use of the Science and Technology learning module on Matter and Its Changes aspect is effective in improving Science Process Skills compared to classes that do not use this module in learning.

Science process skills (KPS) are seen from the results of observations by two teachers. There are 5 indicators of Science Process Skills (KPS) that are observed, including: observing, classification,

prediction, inference, and communication (Bundu, 2006).

Students who use the Project Based Learning learning model in their learning process will have an organized mindset, which is very important in the problem solving process, and will gain scientific knowledge and science process skills. Apart from that, students need to be trained in independence, collaboration and experimentation using this learning model (Zahirah et al., 2024).

The result of science process skills can be seen in table 6.

Table 6. Results of Analysis of Science Process Skills

Aspect of KPS	Control Class			Experiment Class		
	Per 1	Per 2	mean	Per 1	Per 2	Mean
Observing	63.9	70.7	67.3	85.3	88.0	86.7
Classification	57.3	81.7	69.5	82.7	84.0	83.4
Prediction	50.7	76.0	63.4	86.7	84.0	85.4
Inference	62.7	76.7	69.7	81.3	82.7	82.0
Communication	50.7	70	60.4	80	82.7	81.4
mean			66			83.7
criteria			High			Very high

Based on Table 6, it is known that the average value of each indicator of scientific process skills in the experimental class is higher than the average value in the control class. The overall average value of the KPS indicators observed in the experimental class reached a value of 83.7 in the very high category, while in the control class it reached a value of 66 in the high category. This shows that the Science Process Skills (KPS) of students after using the science module on substance material and its changes based on Project Based Learning to improve students' science process skills are significantly higher than before using the science module on substance material and its changes based on Project Based Learning. to improve students' science process skills (Masaguni et al., 2023).

Observation skills are the most basic skills so students can easily complete them because students are used to making observations (Mukra, 2024). In this study, the observation aspect is the aspect that has a KPS value of 86.7. This is because the module is equipped with instructions for using the module for students, students are guided to fill in the observation table that has been provided.

Observation activities help resolve curiosity. Mastery of observation skills has a positive impact on students because it allows them to connect their direct experiences with the theories they know (Nasih et al., 2019).

The second skill is classification skills. In this skill, students are able to determine what tools, materials and sources to use (Hasan, 2024). Able to determine the objectives and usefulness of the results of the practice carried out. The completion result for this skill is 83.4 in the very high category.

The third skill is interpreting or predicting. In this skill, students are invited to carry out work procedures according to the sources obtained, collect initial data and then connect the observation results with the observation data obtained (Zahirah et al., 2024). In this skill, the completion result obtained was 85.4 in the very high category.

The fourth skill is inferring or interference, where students are directed to draw conclusions according to the objectives of the experiment, making logical and relevant conclusions from the results obtained. In the fourth skill, a completeness score of 82 was obtained in the very high category. According to Tawil et al. (2016) concluding or interfering is the activity of writing down the results of experiments that have been carried out, either in the form of data or literacy.

The fifth skill is communicating. This skill received a completeness score of 81.4 in the very high category. Communication can be defined as the activity of articulating concepts and views orally and in writing in various formats of tables, graphs, diagrams and picture (Amanda et al., 2023). In this skill, students present orally using appropriate language and are active in question and answer activities.

Project based learning provides students with the opportunity to create a more interesting and meaningful learning experience, and can improve students' scientific performance in learning, while the teacher's role as facilitator and mediator can be fulfilled well (Nurasiah et al., 2022).

Modules can be used to improve students' science process skills during learning. The module guides students to think logically, critically and systematically because they need to find their own information when studying, and develops students' creativity so they can solve and answer problems (Dewi et al., 2024).

Conclusion

The science module on matter and its changes is based on project based learning to improve the science process skills of Phase E SMK students, which has been produced through research and development with the 4D development model. The science module on Substances and their Changes is based on project based learning to improve the science process skills of Grade E SMK students has a high level of validity with a Aiken's V value of 0.92, very practical practicality from teachers and students respectively with a value of 0, 97 and 0.93 and high effectiveness with a value of 86.09%. The science and science module on Matter and Its Changes based on project based learning can improve learning

outcomes and science process skills for SMK phase E students in the high effectiveness category.

Acknowledgments
A special thanks to my parents who give support system for me, to my lectuter for assitence me and also teachers and student who help this research.

Author Contributions
Conceptualization; E. R. N, H., methodology; E. R. N.,validation; H.: formal analysis.; E. R. N.:investigation.; E. R. N Wresources; E. R. N: data curation: H: writing—original; E. R. N: draft preparation; E. R. N :writing—review and editing: E. R. N ;visualization: H. All authors have read and agreed to the published version of the manuscript.

Funding
This research was independently funded by researchers.

Conflicts of Interest
The authors declare no conflict of interest.

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