14 (2) (2025) 245-254

Unnes Science Education Journal
Accredited Sinta 2

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Development of a Research-Based E-Module on the Medicinal Plant Kesum (*Polygonum minus*) as an Antidiabetic for Enrichment of P5 Activities in Senior High School

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DOI: http://dx.doi.org/10.15294/usej.v13i1.29771

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Article Info

Submitted 2025-06-19
Revised 2025-07-20
Accepted 2025-08-30

Keywords

Antidiabetic, *Polygonum minus*, Pancasila Student Profile (P5)

Abstract

The implementation of the Merdeka Curriculum at the senior high school (SMA) level emphasizes the execution of the Pancasila Student Profile Strengthening Project (P5), which instills character values and local wisdom. However, the learning modules utilized in P5 typically draw inspiration from online sources and frequently neglect to incorporate local potential. On the other hand, the increasing prevalence of diabetes in Indonesia has become an urgent public health issue, while the use of local medicinal plants such as kesum (Polygonum minus) has not been widely integrated into contextual learning in schools. This study aimed to develop a research-based e-module on the medicinal plant Kesum (*Polygonum minus*) as an antidiabetic, integrated with the Projek Penguatan Profil Pelajar Pancasila (P5). The development followed the ADDIE model, which includes the stages of analysis, design, development, implementation, and evaluation. Data were collected through teacher interviews and validation by nine experts in content, media, and language. Validation results indicated that the e-module was highly valid for use, with an average score of 86.82%. The practicality of the e-module was tested in a small group trial (1students), yielding a score of 80.75% (practical category), and in a large group trial (60 students), resulting in a score of 82.45% (highly practical category). The e-module was designed to support project-based learning by addressing local issues, strengthening students' scientific literacy, and promoting local wisdom values. Therefore, this e-module is considered suitable as a contextual learning resource for implementing P5 in senior high schools.

How to Cite

Herniawati, H., Hadiarti, D., & Mukhlishin, H. (2025). Development of a Research-Based E-Module on the Medicinal Plant Kesum (*Polygonum minus*) as an Antidiabetic for Enrichment of P5 Activities in Senior High School. *Unnes Science Education Journal*, 14(2), 245-254.

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p-ISSN 2252-6617
e-ISSN 2502-6232

INTRODUCTION

The Merdeka Belajar curriculum implemented in senior high schools (SMA) mandates the implementation of the Projek Penguatan Profil Pelajar Pancasila (P5) to instill the values of faith and devotion to God Almighty, global diversity, mutual cooperation, independence, and critical thinking (Aditiya & Fatonah, 2023; Barus et al., 2024; Packalen & Rowbotham, 2024). The P5 project with the theme "Voice of Democracy," has been carried out at SMAS Mujahidin Pontianak and SMAN 10 Pontianak, based on interviews with chemistry teachers on September 17 and 25, 2024. In addition to "Voice of Democracy" other themes implemented at SMAN 10 Pontianak include "Entrepreneurship" and "Sustainable Lifestyle and Waste Utilization." The P5 coordinator at the school prepared a module adapted from online sources and tailored to the school's needs. During its implementation, teachers faced several challenges in adapting the module into classroom-based P5 project learning, considering that P5 is still relatively new and requires adjustments from both teachers and the entire school community. One of the main weaknesses of modules adapted from online sources is the limited local content, which tends to overlook local cultural values and leads to dependency on external references. One of the P5 modules used carries the theme "Voice Democracy," which includes objectives, topic relevance to the school, key considerations, achievement targets, core understandings, essential questions, project phases, activity schedules, and detailed project activities. To strengthen local context and foster critical thinking, the P5 project needs to raise real-life issues, such as health problems that are close to students' lives, one of which is diabetes.

Students are expected to develop critical thinking skills to enable them to think logically and systematically in analyzing, making decisions, and solving problems. Project-based P5 learning, which addresses global issues by utilizing local content from West Kalimantan, can foster these skills. Diabetes remains a major global health concern, with approximately 589 million adults aged 20-79 currently living with the condition worldwide. Around 252 million of these individuals are unaware of their condition, increasing the risk of serious complications. Projections indicate that the number of people with diabetes will rise to 853 million by 2050 (IDF, 2025). Complications include damage to the teeth, eyes, heart, kidneys, and feet, caused by impaired blood flow, narrowing, and damage to blood vessels (Avogaro & Fadini, 2014; Ibnu & Hidayati, 2025; Suryanti & Pudjiati, 2025). α-glucosidase inhibitors such as acarbose are commonly used to treat diabetes by lowering blood glucose levels, but they may cause side effects such as bloating, diarrhea, and hepatitis (Li et al., 2016; Rouzbehan et al., 2017; Zhang & Ma, 2023). A study on medicinal plants from West Kalimantan that can be integrated into P5 learning to address diabetes focuses on Kesum (Polygonum minus).

Polygonum minus, commonly known as kesum, has long been used as an ingredient in traditional West Kalimantan cuisine, particularly in a dish called Bubur Pedas (Kartikasari et al., 2022; Merdekawati et al., 2024). The n-hexane fraction of P. minus has been proven to reduce blood glucose levels in Rattus norvegicus induced with alloxan at a dose of 200 mg/kg body weight. After seven days of alloxan administration, blood glucose levels decreased to 128 mg/dL (at 150 mg/kg BW) (Sumartini et al., 2015; Wibowo et al., 2015). Kesum also exhibits potential as an antibacterial, anticancer, antioxidant, antifungal, and antimicrobial agent (Anugrahini & Wahyuni, 2021; Dewi et al., 2019; Winanta et al., 2024). As a sustainable herbal remedy for diabetes, Polygonum minus aligns with the local wisdom of Indonesian communities. Although herbal medicine is widely used, many such products are herbal-based products from plant, animal, or mineral extracts whose efficacy and safety have been scientifically tested (Diina et al., 2022; Mustakim, 2020; Mustapa et al., 2020). The local potential of kesum can be utilized in education, particularly to support the Projek Penguatan Profil Pelajar Pancasila (P5). Therefore, it is necessary to develop a P5 module that integrates kesum as an antidiabetic agent to instill local wisdom, scientific literacy, and contextual learning among students.

The P5 module includes procedures for preparation, implementation, data analysis, and appropriate laboratory experiment reporting. It is available in both printed and digital (e-module) formats to support online learning (Haryani et al., 2022; Riza et al., 2020). E-modules offer significant benefits in education, including anytime accessibility, interactive elements that enhance engagement, personalized learning, cost efficiency, ease of content updates, access to diverse resources, and better utilization of environmental resources (Farahin Rachman Laraphaty et al., 2021; Mustakim & Jumini, 2020; Septryanesti & Lazulva, 2019). Learning modules can be developed by incorporating local content so that students can be guided according to the learning objectives while also fostering their awareness to

preserve, sustain, and develop the environment (Iswan et al., 2025; Rahma et al., 2023; Riza et al., 2020). In the implementation of P5 in high schools, the development of modules that include local content enables students to actively engage in the learning process, especially in relation to local issues and the natural potential surrounding them.

Several researchers have utilized medicinal plants containing local content, such as studies on the medicinal plant Premna serratifolia (locally known as daun buas-buas). A research-based e-module on Premna serratifolia has been developed, receiving validation scores of 85.4% for content, 82.6% for media, and 81.5% for language aspects. The practicality of the e-module was evaluated through preliminary and final field trials, which produced scores of 80.8% and 87.2%. These results demonstrate that the e-module is both appropriate and effective for high school student use (Sari et al., 2024). Another development involved an e-module incorporating local content in acid-base indicators. The teacher assessment score reached 77% (categorized as effective), and the student assessment score reached 87.32% (categorized as highly effective), resulting in an average effectiveness score of 82.16%, classified as highly effective (Fatihah, 2023). A research-based e-module on the physical and chemical properties of aquatic environments has also been developed, achieving a feasibility score of 91.4% for use (Rahma Shafira et al., 2023). E-modules that utilize local content as self-learning resources have been proven to be both feasible and practical for student use.

However, there has not yet been any development of research-based e-modules that specifically integrate local plants as antidiabetic agents within the context of implementing the Pancasila Student Profile Strengthening Project (P5) in secondary schools. This gap is important to address, considering that diabetes is a global health issue closely related to students' lives, and the potential of local plants such as *Polygonum minus* (kesum) remains largely untapped in project-based science learning. This study aims to develop a research-based e-module on the medicinal plant Kesum (*Polygonum minus*) as an antidiabetic agent, which can be utilized in the Pancasila Student Profile Strengthening Project (P5) at the senior high school level. The main focus of this research is to assess the validity and practicality of the e-module within project-based learning that highlights the local potential of West Kalimantan. The urgency of this research stems from two main issues: first, the increasing prevalence of diabetes mellitus in Indonesia, which highlights the need for early preventive education, especially among students; and second, the lack of innovative teaching materials that integrate local wisdom while supporting the implementation of P5 in secondary schools. Although Indonesia is rich in medicinal plants such as *Polygonum minus*, their potential remains underutilized in science education.

Previous studies have predominantly explored the pharmacological properties of Polygonum minus, particularly its antidiabetic activity, without linking these findings to educational applications. Moreover, there is a scarcity of high-quality learning media aligned with P5 themes such as "Sustainable Lifestyle," especially those based on local natural resources and scientific research.

This study addresses these gaps by developing a research-based e-module that connects the antidiabetic potential of *Polygonum minus* with project-based learning in the P5 framework. This approach is expected to enhance students' scientific literacy and critical thinking while fostering appreciation for local biodiversity and sustainable living practices.

METHOD

This study is a research and development (R&D) study aimed at producing a research-based e-module on the medicinal plant kesum (*Polygonum minus*) as an antidiabetic agent to support the Pancasila Student Profile Strengthening Project (P5) in senior high schools. The development model used is the ADDIE model, which consists of five stages: analysis, design, development, implementation, and evaluation (Alwan Zainul Haq et al., 2023; Islahiyah et al., 2021). Data collection was conducted through direct interviews with teachers during the co-curricular analysis phase and through questionnaires during the needs and student characteristics analysis phase (Masturoh & Mahmudi, 2023).

A total of 26 students and 4 teachers were involved in the analysis stage, e-module development, and research instrument preparation. The validation process was carried out by 9 validators, consisting of content, media, and language experts. Implementation was conducted in the school environment, and evaluation was based on user feedback. The validation used a 4-point Likert scale (1 = strongly disagree to 4 = strongly agree), and the results were calculated using the following percentage formula.

$$P = \frac{\Sigma R}{\Sigma N} X\ 100\%$$

Where:
P : Percentage score of the validator
ΣR : Total score given by the validator
ΣN : Maximum possible score

The e-module validation results were classifie according to the criteria presented in Table 1.

Table1. Validity Criteria

Percentage (%)	Criteria
25 - 43	Not Valid
44 - 62	Less Valid
63 - 81	Valid
81 - 100	Highly Valid

(Rismayanti et al., 2022)

After receiving input from experts, revisions were made to improve the content and visual design of the e-module. The implementation stage continued by distributing the e-module in PDF format to students as an initial and final trial (Musfiqi & Jailani, 2014; Samsu et al., 2020). In addition, student response questionnaires were distributed at SMAN 10 Pontianak and SMAS Mujahidin Pontianak to measure the students' comprehension and how practical value of the e-module. The data analysis technique used was quantitative analysis, by processing the collected data and adjusting the obtained scores based on the criteria presented in Table 2.

Table 2. Practicality Criteria

Percentage (%)	Criteria
25 - 43	Not Practical
44 - 62	Less Practical
63 - 81	Practical
81 - 100	Highly Practical

(Rismayanti et al., 2022)

RESULT AND DISCUSSION

The developed e-module was validated by nine experts consisting of subject matter, media, and language specialists. The validation results indicate that the e-module is highly valid, with an overall average score of 85.34%. Specifically, the material aspect received a score of 83.3%, the media aspect 81.01%, and the language aspect 91.72%. These scores demonstrate that the e-module meets the eligibility criteria in terms of content, media presentation, and appropriate language use for senior high school students.

The high score in the language aspect shows that the e-module uses clear, communicative language that adheres to linguistic conventions. The language used has proven effective in helping students independently understand scientific concepts without causing confusion. This aligns with findings that e-modules utilizing simple and structured language can enhance the effectiveness of learning and student comprehension (Fatihah, 2023). Other studies have also shown that a strong language component—especially in terms of clarity and readability—significantly influences students' learning interest and active engagement in independent learning (Rismayanti et al., 2022). Emphasis on language clarity becomes a crucial aspect in contextual learning, such as in the implementation of the P5 project.

Practicality testing was carried out through a limited trial involving two teachers and 72 students. The results showed that the e-module was considered highly practical for use in learning activities. Both teachers and students found the module easy to understand, engaging, and relevant to the implementation of the Pancasila Student Profile Strengthening Project (P5), particularly under the theme of "Sustainable Lifestyle." These findings are supported by research indicating that research-based e-modules integrating local content can enhance students' understanding and active participation in the learning process (Rahma Shafira et al., 2023; Sari et al., 2024).

The success of this e-module development is consistent with Vygotsky's constructivist theory, which emphasizes the importance of contextual and meaningful learning experiences. This theory posits that students construct knowledge through interactions with their social and cultural environments (Fadillah et al., 2025; Nurfatimah Sugrah, 2020). In this context, the use of the local plant kesum (*Polygonum minus*) as the central topic of the module not only connects the material with students' real-life experiences but also strengthens the values of local wisdom as part of cultural identity.

Thus, the high validity and practicality results prove that this e-module product is suitable and effective for application in secondary school learning. Specifically, the e-module contributes to supporting the implementation of P5 through contextual learning that strengthens scientific literacy, understanding of health issues, and the internalization of Pancasila Student Profile values such as critical thinking, independence, and environmental awareness.

Analysis Stage

At this stage, the researcher analyzed the problems faced by both students and teachers, as well as identified students' learning needs. To ob-

tain this information, questionnaires were distributed to students who would be participating in the Pancasila Student Profile Strengthening Project (P5), and interviews were conducted with two teachers from senior high schools in Pontianak. In addition, a needs analysis was conducted involving 26 students from two senior high schools in Pontianak to identify the fundamental challenges in implementing the P5 project. Observation results showed that 41.02% of students found the P5 activities enjoyable, 43.59% felt neutral, and 20.49% considered them boring. Interestingly, nearly all students preferred using electronic learning resources via smartphones. Therefore, there is a need for learning materials that incorporate local content, such as medicinal plants, to help students better understand the benefits of local medicinal plants.

Design Stage

In the design stage, the main focus was directed toward developing the structure and components of the e-module in accordance with the needs of project-based learning in senior high schools. The e-module was designed to integrate scientific research findings on Kesum (*Polygonum minus*) with contextual learning under the theme "Sustainable Lifestyle" within the Pancasila Student Profile Strengthening Project (P5). The design of the e-module includes several key components: a concept map and learning objectives; a main section containing material on diabetes and Kesum as an antidiabetic agent, along with simple experimental procedures; and a final section consisting of practice questions. All content was developed to align with the Merdeka Curriculum and the implementation of P5 in schools.

The learning media was designed in an interactive digital format to ensure accessibility via students' smartphones. Visual elements, such as font size, font type, and layout, were selected based on readability principles and user comfort (Manurung, 2021). The module used A5 paper dimensions, Arial typeface in 10-point size, and 1.15 line spacing to maintain consistent formatting. In addition to content development, this stage also involved the preparation of research instruments, including validation sheets for content, media, and language experts, as well as student response questionnaires. These instruments were used to measure the validity and practicality levels of the e-module in the subsequent development and implementation stages.

Development Stage

In the initial stage of development, the preliminary design of the e-module was created, including the front and back cover designs as well as the main content containing scientific information about Kesum (*Polygonum minus*), as illustrated in Figure 1. The module was developed in an electronic PDF format to ensure easy access for students and to support their learning styles (R.Roro Rastrani Rahada Putri et al., 2022).

Once the initial design was completed, e-module underwent a validation process conducted by nine experts consisting of content, media, and language validators. Evaluation was carried out using a four-point Likert scale validation instrument (Auliany et al., 2024). According to evaluations given by validators, e-module was considered highly valid, achieving an average validation score of 86.82%. This percentage indicates that e-module is appropriate for use in learning, although some suggestions for improvement were addressed before conducting field trials.

Figure 1. The E-Module's Front and Back Covers

A review of the e-module content was conducted by one expert from a university and two experts from senior high schools in Pontianak, all of whom have expertise in medicinal plant research, particularly in the field of antidiabetic activity. The evaluation was based on four main criteria that reflect the completeness and accuracy of the content. The assessment results of the material aspect show that the material coverage component received the highest score, reaching 95.83%, as shown in Figure 2.

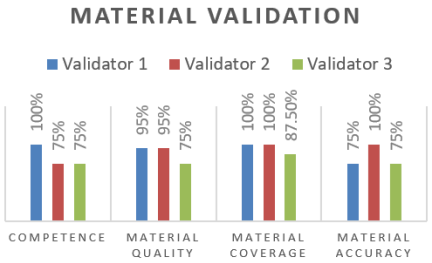
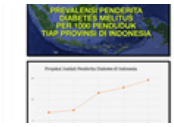
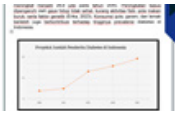
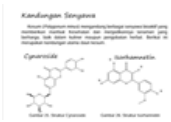
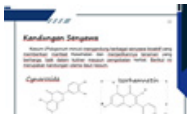


Figure 2. Visualization of E-Module Content Suitability Scores

The assessment results also indicate that the material accuracy aspect received a score of 83.3%, signifying that the scientific information

presented in the e-module regarding the potential of *Polygonum minus* as an antidiabetic is in accordance with theoretical foundations and current research findings.

Table 3. Revisions Based on Content Expert

Suggestions	Revisions	
	Before	After
"Remove the image of diabetes prevalence"		
"Provide bullet points that indicate the topics to be discussed"		
"The title should be written in bold"		

The assessment of the media aspect in the e-module covered several components, including cover design (layout, typography, illustrations, and color), content design (content clarity), and graphics (audio and video). The overall score for the media aspect was 81.01%, categorized as highly valid, as shown in Figure 3. The highest average score of 87.5% was given to the cover design aspect, while the lowest score of 75% was given to the graphics aspect.

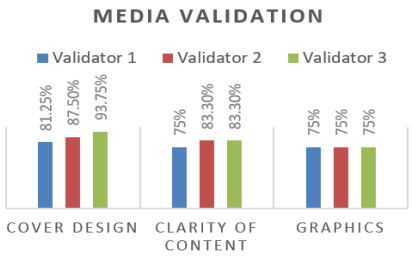


Figure 3. Visualization of E-Module Media Suitability Scores

The suggested improvements included adjustments to layout and color of cover, as well as ensuring the transparency of image backgrounds.

Table 4. Revisions Based on Media Expert

Suggestions	Revisions	
	Before	After
"The layout and cover color should be improved"		
"Revise the background content of the e-module to be more creative and adjust it to match the cover color"		

The suitability of the language aspect included several indicators, such as adherence to Indonesian language rules, communicativeness, and clarity, resulting in a score of 91.72%, categorized as highly valid. The clarity aspect received the highhest score, 97.23%, while adherence to language rules and communicativeness received scores of 91.7% and 86.23%, respectively. The results of this evaluation are presented in Figure 4.

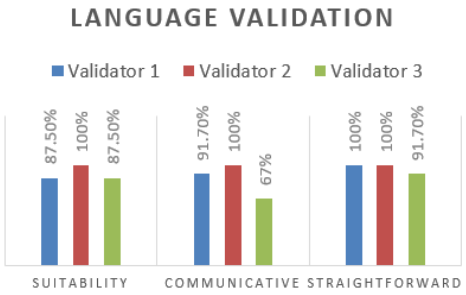
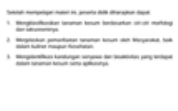


Figure 4. Visualization of E-Module Language Suitability Scores

Writing of the author's name on the cover, learning objectives, and the titles and subtitles on images. These revisions were carried out as a follow-up to expert suggestions, as listed in Table 5.

Table 5. Revisions Based on Language Expert

Suggestions	Revisions	
	Before	After
"Remove the period after the phrase (prepared by), and end academic titles with a period"		
"The learning objectives section needs to be revised by placing the phrase "peserta didik" at the		

beginning and writing the bullet points without capital letters at the beginning or periods at the end"	
"The titles and subtitles in the images should be written in bold"	

Implementation Stage

The implementation stage was carried out after the research-based e-module on the medicinal plant kesum (*Polygonum minus*) was declared feasible based on validation results. The e-module that was developed was initially distributed to students in Word format before being converted into a PDF. After the conversion, the PDF version was shared with students through social media platforms, along with an introductory explanation outlining the purpose of using the module within the P5 project-based learning framework. This stage aimed to facilitate readability testing and assess the practicality of the e-module in learning about kesum as an antidiabetic plant.

Evaluation Stage

At this stage, the practicality of the developed e-module was assessed through a readability trial involving students from several prominent schools in West Kalimantan, specifically SMAN 10 Pontianak and SMAS Mujahidin Pontianak. The evaluation process included a small group trial involving 12 students on June 2-3, 2025, and a final trial involving 60 students on June 12-13, 2025. Overall, the trials involving a total of 72 students yielded a practicality score of 80.75%, which falls into the practical category.

This score is slightly lower compared to previous studies on research-based e-modules, which reported practicality scores of 95.61% and 84.15%, respectively. However, the results still indicate that developed e-module received a positive response from students (Rahma Shafira et al., 2023; Sari et al., 2024). The difference in results is presumed to be related to the unequal number of respondents in the initial and final trials, which involved 27 and 20 students, respectively.

Small Group Trial Results

During the small group trial, response questionnaires were distributed to teachers at the two previously selected schools to gather feedback on students's experiences using the e-module. The purpose of this activity was to evaluate the module's suitability and paracticality based on initial user impressions.

Based on the analysis results, the overall practicality score was 80.76%, indicating that the e-module is considered feasible and practical for use. The detailed results show that the analysis aspect received a score 80.23%, evaluation 81.88%, inference 81.25%, interpretation 81.25%, and reflection 79.17%. with these scores, the analysis an reflection aspects fall into the practical category, based on the practicality range of 63% to 81%, while the remaining aspects are categorized as highly practical, within the range 81% to 100%.

Table 6. Small Group Trial Results

Aspect	Percentage	Category
Analysis	80.23%	Practical
Evaluation	81.88%	Highly Practical
Inference	81.25%	Highly Practical
Interpretation	81.25%	Highly Practical
Reflection	79.17%	Practical

Large Group Trial Results

During the large group trial, teachers at the participating schools were asked to complete questionnaires to collect data on the usability of the e-module. Based on the evaluation results, a practicality score of 82.42% was obtained, indicating thet the e-module falls into the highly practical category. The detailed scores show that the analysis aspect received 82.62%, evaluation 82.95%, inference 82.38%, interpretation 82.42%, and reflection 81.80%. these values place the e-module within the high practicality range, which is between 82% and 100%.

Table 7. Large Group Trial Results

Aspect	Percentage	Category
Analysis	82.62%	Highly Practical
Evaluation	82.88%	Highly Practical
Inference	82.38%	Highly Practical
Interpretation	82.42%	Highly Practical
Reflection	81.80%	Highly Practical

The results of the large group trial in this study showed showed that the e-module received a positive response from students, with a practicality score of 82.42%, and was effective in helping them understand the material better.

CONCLUSION

The development of a research-based e-module on the medicinal plant kesum (*Polygonum minus*) as an an-tiabetic has proven effective in supporting the implementation of the Pancasila Student Profile Strengthening Project (P5) based on local wisdom. The developed module was rated highly valid by experts, with a validity score of 86.82%, and was found to be practical for use in learning, with an overall practicality score of 80.75%. This e-module is not only relevant to students' preference for digital media but also introduces the potential of local plants within meaningful and contextual learning. Therefore, the e-module is suitable for implementation in project-based learning activities at the senior high school level.

ACKNOWLEDGMENT

The author would like to express sincere gratitude to the Chemistry Education Department of Universitas Muhammadiyah Pontianak for the academic support provided throughout the research and development process. Appreciation is also extended to the nine expert validators in the fields of content, media, and language for their constructive feedback, which significantly contributed to the improvement of the e-module. The author also acknowledges the valuable participation of two chemistry teachers and 72 students from SMAN 10 Pontianak and SMAS Mujahidin Pontianak during the implementation stage. This research was funded by the Directorate General of Higher Education (DIKTI) through the Student Creativity Program (Program Kreativitas Mahasiswa/PKM).

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