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Project-Based Learning E-Modules Based on Research Results on the Nutritional Content of Sawi Asin (Fermented Mustard)

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***Abstract**: The project-based learning model focuses on directing students to be more active in learning. The learning model will be effective if combined with e-module media. Because e-modules provide facilities for students to learn independently. One of the materials in class XII Biology that is applied in e-modules is biotechnology related to local potential, namely Sawi Asin fermentation. The study aims to develop project-based learning e-modules based on research results on the nutritional content of Sawi Asin fermentation. The research method uses Research and Development which adapts the Alessi and Trolip development model. There are three stages carried out, namely, planning (planning), designing (design), and developing (development). The results of e-module validation by media experts showed an average score of 94.22% (very feasible), material experts 80.83% (feasible), and language experts 87.333% (very feasible). The results of the small group test with 12 students of class XII IPA showed an average value of 81.09% (very positive) and the large group test with 32 students of class XII was IPA 87.04% (very positive). It can be concluded that the project-based learning e-module based on the results of research on the nutritional content of Sawi Asin fermentation is very feasible to use and gets a very positive response from students.*
***Keywords**: E-module, Development, Project Based Learning*

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INTRODUCTION

Students are allowed to work autonomously to construct their way of learning In the PjBL learning model. In line with Hamidah & Citra (2021) state that The Project Based Learning (PjBL) learning model is innovative learning that centers on students being more active in learning and places educators as facilitators. During the learning process, they will identify problems and seek their solutions, through projects to produce products (Surya et al., 2018). The application of the PjBL model is more encouraged in design activities, formulating actions, designing actions, calculating the possibility of each action, implementing actions, and evaluating results (Pratama & Rosana, 2016) to improve student's abilities in conceptual learning and creativity (Astuti et al., 2019).

The application of the PjBL learning model will be more effective if combined with media. This is supported by the results of research conducted (Barlenti et al., 2017) that applying PjBL-based worksheets can improve students' concept understanding. The t-test results show that there are differences before and after the use of PjBL-based worksheets seen from the students' pretest and posttest scores. Student responses to the application of PjBL-based worksheets received positive

responses from students. The result showed by (Martalia et al., 2022) PjBL-based e-book teaching materials on learning theme 8 subtheme 2 can strengthen science literacy. PjBL-based E-book teaching materials received positive responses from students on aspects of fun, interesting, increased interest in learning, easy to understand, and useful because in there is practice students are more happy and enthusiastic about learning.

Learning media is a tool that can help the teaching and learning progress so that the meaning of the message conveyed becomes clearer and learning objectives can be achieved effectively and efficiently (Nurrita, 2018). One of the learning media that can be used is e-modules. The advantages of e-modules lie in two-way communication that can be used for distance education or training, interactive and clearer structure. In addition, e-modules provide facilities for students to learn independently. Using e-modules students can learn anytime and anywhere (Rahmadhani et al., 2021). The results of the research were conducted (Syahrial et al., 2019). Students have good perceptions, interests, and motivation after being introduced to e-modules in the learning process. The use of e-modules makes students more interested in learning, therefore it is highly recommended for teachers to use e-modules in the learning process.

Judging from the PJBL learning model, one of the appropriate subjects is Biology. Studying biology emphasizes understanding concepts and process skills that are carried out simultaneously. In Biology subject, there is one of the materials, namely biotechnology. Biotechnology material includes conventional and modern biotechnology. The subject matter regarding food fermentation to cloning in animals is a very large and broad material (Anantyarta & Sholihah, 2020). Biotechnology is an applied science application that uses living things to produce products (Fadhilah et al., 2021). Fermentation is a preservation method that can maintain the nutritional value of food and extend the shelf life by utilizing microorganisms (Hayati et al., 2017). One of the traditional fermented products in West Kalimantan is sawi asin.

Sawi Asin is a traditional fermented food made from village mustard also known as ansabi (*Brassica juncea*) (Megawati et al., 2020). Ansabi is a local potential from KapuasHuluu whose habitat is in the fields. Because ansabi is not very durable in storage, the community took the initiative to make fermented ansabi or Sawi Asin greens. The microorganisms involved in Sawi Asin fermentation are usually dominated by lactic acid bacteria (LAB). Naturally, the lactic acid bacteria involved in Sawi Asin fermentation are *Leuconostoc mesenteroides, Lactobacillus brevis, Lactobacillus plantarum, and Pediococcus cerevisiae*. The fermentation process occurs in the decomposition of compounds that will change the texture, color, taste, aroma, and nutritional content of Sawi Asin (Lembong et al., 2022). Sawi Asin can be used as an additional food that functions as an appetite generator (Marsigit & Hemiyetti, 2018). So it is necessary to do a proximate analysis, namely (an analysis of water content, ash content, crude protein content, and crude fat content).

Based on the description above, in addition to developing PjBL e-modules and determining biotechnology material, learning media will also be very effective if it can provide information and real situations regarding local potential in Kapuas Hulu related to biotechnology material, namely Sawi Asin fermentation. This is supported by the results of research (Ramdayani et al., 2021) that learning is in a very effective category because the handout media uses a contextual approach to the local potential of the Green Valley of Rumbia Jeneponto. So researchers are interested in developing project-based learning (PjBL) e-modules based on research results on the nutritional content of Sawi Asin fermentation as teaching material for Biology class XII SMA Muhammadiyah 1 Pontianak.

This study aims to describe the development of project-based learning e-modules based on research results on the nutritional content of Sawi Asin fermentation. So that it adds teaching materials for educators and helps deliver material more easily. Through this research, it can also facilitate students in learning biology material in an integrated manner, especially biotechnology material.

METHOD

The research used a Research and Development (R&D) method that adapted the Alessi and Trollip development model. This model consists of three stages, namely, planning, design, and development (Yayah Huliatunisa, 2022).

At the planning stage, the data collection techniques used were interviews and observations. Interviews were conducted with biology teachers. Observations made are systematic recordings with

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visible elements from the research site. The steps taken are front-end analysis, student analysis, task analysis, concept analysis, and formulation of learning objectives. Furthermore, the design stage is to prepare the e-module framework. This stage includes the preparation of instruments, the preparation of research designs, and the selection of media formats. At the development stage, the data collection techniques used are expert validation and indirect communication with data collection tools, namely expert validation sheets and questionnaires using a Likert scale. The Likert scale is one type of itemized rating scale used to assess the level of agreement and disagreement of respondents on a statement. In this study, researchers used 5 Likert scale ratings, namely (1) Strongly Disagree, (2) Disagree, (3) Disagree, (4) Agree, (5) Strongly Agree. Researchers and several experts such as material, media, and language experts verify the product, evaluate the development process and feasibility of the developed e-module product, and then modify the product.

The data used is quantitative descriptive analysis to determine the feasibility and student response to the media developed by being validated by experts and practitioners. Learning media is categorized as feasible to use if the percentage of validation test results by validators is more than 61% (Mashuri, 2020). The criteria for student feasibility/response to learning media are described in Table 1 as follows:

Table 1. Learning Media Criteria

Percentage	Criteria	
	Feasibility	Students' Response
81% - 100%	Very Worthy	Very Positive
61% - 80%	Worthy	Positive
41% - 60%	Worthy Enough	Positive Enough
21% - 40%	Less Worthy	Less Positive
0 – 20%	Not Worthy	Not Positive

RESULT AND DISCUSSION

The development product produced in the study is a Project Based Learning (PjBL) e-module based on the results of research on the nutritional content of Sawi Asin fermentation. The advantages of the PjBL e-module based on the results of research on the nutritional content of Sawi Asin fermentation are interactive, easy to navigate, allows for displaying images, is durable, and more practical to carry (Erdi & Tivsi, 2022) and equipped with projects to make students more familiar with local potential and able to solve problems. The development research procedure refers to the Alessi & Trollip model by going through 3 stages, namely the planning stage, the design stage, and the development stage (Yayah Huliatunisa, 2022).

In the planning stage, researchers begin by determining the purpose of making media and preparing several aspects used to start developing learning media. Activities carried out at this stage include:

Front-end analysis was conducted through interviews. This stage aims to bring up and determine the basic problems faced in biology learning. Based on the results of interviews in the learning process, teachers use media that is quite varied such as LKPD, power points, videos, pictures, and the use of the internet to find information. E-modules have been used but not combined with PjBL so learning models like this are a novelty for class XII SMA Muhammadiyah 1 Pontianak students, especially on biotechnology material. After analyzing the front end then with student analysis.

Student analysis can be concluded from the results of interviews with teachers. The results of the interview found that students like interesting and digital-based media such as utilizing Android phones they use so that students are not bored during the learning process and only use printed media and do not need to bring many books to school. For students to be motivated to achieve learning objectives, the display in the PjBL e-module media is equipped with colorful images. According to (Isnaeni & Hildayah, 2020), the existence of learning media makes students think broadly to get more and varied information and students can gain real experience so that the content of the material taken in the learning process can be stimulated properly and effectively by the methods used.

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The researcher then conducted a task analysis. Task analysis is carried out by identifying the competency standards and basic competencies needed in learning and then analyzing them into a more specific indicator framework. The results of the analysis of basic competencies and learning indicators, fermented foods can be integrated into the theme of biotechnology learning in class XII MIPA. The next stage is concept analysis.

Based on concept analysis, at this stage, the researcher determines the material to be taught in the PjBL e-module. In this case, biotechnology learning materials such as understanding biotechnology, basic principles of biotechnology, and types of biotechnology are divided into two, namely conventional biotechnology and modern biotechnology. However, this e-module dominates the explanation of conventional biotechnology by making salted mustard greens. The next stage is the formulation of learning objectives.

At the stage of formulating learning objectives, researchers determine learning objectives by analyzing core competencies and basic competencies. Through the analysis of core competencies and basic competencies, researchers can find out the basic concepts of biotechnology based on Sawi Asin fermented foods so that it can also determine the projects that students will do to realize learning objectives.

The design stage is to develop all ideas, and content, which have been obtained from the planning stage, determining the material (Arianti et al., 2022) biology. In other words, it aims to design learning media. The steps taken at this stage are the preparation of a research design by collecting data on the nutritional content of Sawi Asin fermentation, namely analyzing proximate (water, ash, protein, fat, and carbohydrates) in Sawi Asin fermentation carried out at the Integrated Laboratory of the Muhammadiyah University of Pontianak.

Table 2. Results of Proximate Analysis of Fermented Sawi Asin

Day-	Nutrient content (%)				
	Water	Ash	Proteins	Fats	Carbohydrates
0	64,95	24,4	1,43	0,89	8,33
3	66,9	27,5	1,01	0,55	4,04
7	66,89	25,6	0,87	0,67	5,97

Macronutrients consisting of carbohydrates, fats, and proteins are needed in large enough quantities for the human body, while micronutrients consisting of vitamins and minerals, although needed in small amounts for the body, must continue to be supplied so that the body is healthy. In addition, the food also contains crude fiber and water which function to facilitate digestion. Ash content is a representation of mineral content in the body.

The selection of learning media in the form of PjBL e-modules aims to facilitate the learning process and become a novelty in the learning model because PjBL e-modules have never been used in class XII IPA Muhammadiyah 1 Pontianak on biotechnology material. Furthermore, the selection of the PjBL e-module media format is edited using Canvas, saved in pdf form, and uploaded on the site https://fliphtml5.com/. The e-module design produced by researchers as an initial product uses a modified e-module format proposed by (Sari & Sri, 2021) which consists of a cover, preface, core competencies, and basic competencies, table of contents, instructions for use, description of biotechnology material, projects, and bibliography. The results of project-based learning e-module media based on research results on the nutritional content of Sawi Asin fermentation can be seen in Figure 1 and Figure 2.

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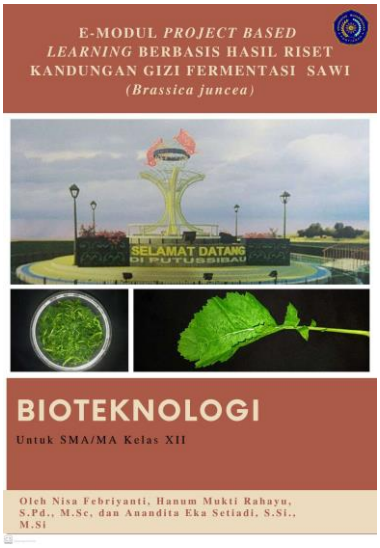
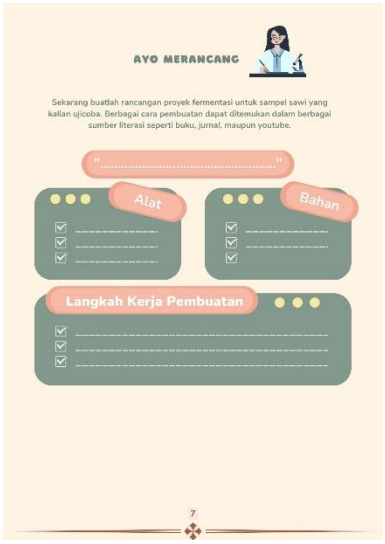


Figure 1. Cover E-Modul *Project-Based Learning*

The cover contains information about the e-module which consists of the title of the e-module, supporting images, the author's name, the author's institution, and the target users of the e-module (Asmiyunda et al., 2018).

(a)



(b)

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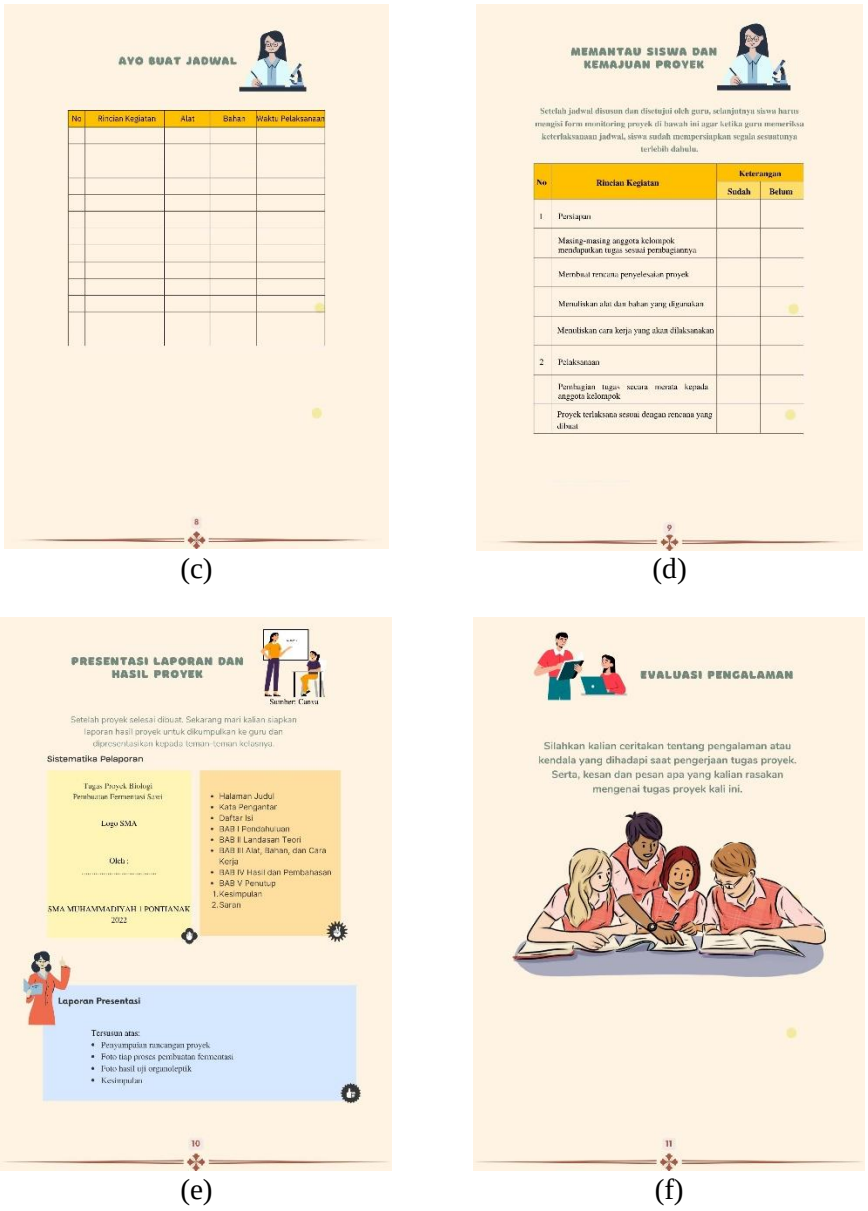

(c) (d)

(e) (f)

Figure 2. Display of the Stages of Project Work (a) Designing (b) Creating a Schedule (c) Assisting Students and Project Progress (d) Presentation of Project Reports and Results (f) Evaluation of the Experience

The presensation to the problem is to provide knowledge about biotechnology material by providing stories about some traditional foods around and some references to previous related articles. Furthermore, make plans with various literacy sources such as books, journals, YouTube, and the surrounding community. Then arrange scheduling during the project creation process. After that, monitor the making of the project, where the teacher monitors students and the progress of the project. Conduct an assessment by having students present by explaining the project made.

The development stage develops and validates the media as well as the development of supporting materials and strategies needed (Hidayat, 2021). In another sense, it aims to produce a revised PjBL e-module based on input from experts. This stage consists of 2 stages of testing so that the resulting PjBL e-module can be said to be valid and suitable for use in learning. These tests include testing the feasibility aspect.

Feasibility of Project-Based Learning E-Modules Based on Research Results on Nutritional Content of Fermented Sawi Asin

Module feasibility assessment is an activity to assess whether the module that has been developed is suitable for use or not (Ningrum et al., 2018). The feasibility of PjBL e-modules based on research

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results on the nutritional content of Sawi Asin fermentation with the validity of e-modules assessed by 9 experts who have disciplines in the fields of learning media and biology. Three aspects are validated, namely: media, material, and language aspects, each aspect is validated by 3 experts.

The feasibility of PjBL e-module learning media is obtained through expert assessment. There are nine experts from 3 aspects, namely in the media aspect (2 lecturers and 1 teacher), material aspect (2 lecturers and 1 teacher), and language aspect (2 lecturers and 1 teacher). The results of the expert assessment can be seen in the following table:

Table 3. Media Expert Assessment Results

Expert	Feasibility (%)	Criteria
Intermediate Expert	94,22	Very Worthy
Material Expert	80,83	Worthy
Linguist	87,33	Very Worthy
Average	87,46	Very Worthy

Media expert validation is to determine the suitability of the appearance of the product produced. 3 indicators of assessment are considered from the product, namely the suitability of teaching materials, the design of teaching materials, and the appearance of e-modules. The results of the learning media expert validation on the PjBL e-module based on the results of research on the nutritional content of Sawi Asin fermentation obtained an average percentage of 94.22%. The results of the percentage gain are interpreted using Table 1. Based on the feasibility table, it is known that the percentage of 94% is included in the very feasible category. This proves that the e-module produced has been categorized as very feasible by media experts. Because the presentation and preparation of e-modules have fulfilled the framework of an e-module, which has an initial, content, and closing section. The initial part of the e-module includes a cover, preface, core competencies, basic competencies, table of contents, and instructions for use. Then it has a content section consisting of activity titles, material descriptions, examples, and student projects. Furthermore, it also has a closing section consisting of a bibliography and an author profile.

Material validation is to determine the accuracy and suitability of the material content aspects of the product developed whether it is by learning needs or not by learning needs. The assessment consists of material indicators. The results of the validation of learning media experts on the PjBL e-module based on the results of research on the nutritional content of Sawi Asin fermentation obtained an average percentage of 80.83%. The results of the percentage gain are interpreted using Table 1. Based on the feasibility table, it is known that the percentage of 80% is included in the feasible category. This proves that the e-module produced has been categorized as feasible based on material experts because the e-module already has material suitability with core competencies, basic competencies, learning indicators, and learning objectives. The images in the e-module are accurate and the material presented is based on real situations close to students so that it is easy to imagine and learn.

Assessment by linguists aims to determine the accuracy of the language used in the media. The assessment consists of language indicators. The results of the validation of learning media experts on the PjBL e-module based on the results of research on the nutritional content of Sawi Asin fermentation obtained an average percentage of 87.33%. The results of the percentage gain are interpreted using Table 1. Based on the feasibility table, it is known that the percentage of 87% is included in the very feasible category. This proves that the e-module media produced is very feasible based on linguists. Because the language contained in the e-module has met the rules of good language and is easily understood by students. The use of punctuation in sentences is appropriate. The harmony and integration between paragraphs are sustainable as well as the stages of the project carried out by students.

Student Response to Project-Based Learning E-Module Media Based on Research Results on Nutritional Content of Fermented Sawi Asin

Student response is the student's response to the developed media. Student response will be low if students feel less interested in the media developed. To find out the student's responses, a questionnaire was given. Student response data is obtained through two stages, namely small-scale trials and large-scale trials. Small-scale and large-scale trials were carried out after the validation of media experts, material experts, and linguists and the revision of media according to expert suggestions. The results of

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student responses to the PjBL e-module media based on research results on the nutritional content of Sawi Asin fermentation can be seen in Table 4 as follows:

Table 4. Student Response Results

No	Indicator	NRS (%)		Criteria	
		Small-Scale	Large-Scale	Small-Scale	Large-Scale
1	Display of Project-Based Learning E-module	87,99	91,71	Very Positive	Very Positive
2	The instructions in the Project-Based Learning E-module are clear and easy to understand.	79,99	87,18	Positive	Very Positive
3	The language used in the Project-Based Learning E-Module is easy to understand.	81,66	87,16	Very Positive	Very Positive
4	Project-Based Learning E-Modules help understand the material learned	78,88	85,72	Positive	Very Positive
5	Project-Based Learning E-Modules can increase learning motivation	76,94	83,43	Positive	Very Positive
	Average	81,09	87,04	Very Positive	Very Positive

Based on the data in Table 4, the results of data analysis of student response questionnaires in small-scale trials conducted on 12 students of class XII IPA 2 previously selected based on high, medium, and low academic categories explained the results of the percentage of student response of 81.09%. The results of the percentage obtained are interpreted using Table 1. Based on Table 1, it is known that the percentage of 81% is included in the very positive category.

Based on the data in Table 4, the results of data analysis of student response questionnaires in large-scale trials conducted on 32 students of XII IPA 1 and XII IPA 3 classes who had previously been selected based on high, medium, and low academic categories explained the results of the percentage of student response of 87.04%. The results of the percentage obtained are interpreted using Table 1. Based on the student response table, it is known that the percentage of 87% is included in the very positive category. From the results of small-scale and large-scale trials that have been carried out, it can be concluded that the PjBL e-module media is said to be feasible to use because the results of the student response questionnaire get a very positive response.

The positive response given by students is because learning with PjBL e-modules is a new thing for class XII IPA students at SMA Muhammadiyah 1 Pontianak and makes students more interested in studying biology. This is in line with research (Latifah et al., 2020) that students find it easier and more interesting to learn than they have to open printed books. And also the PjBL e-module based on the results of research on the nutritional content of Sawi Asin fermentation can support students' independent learning process, the results of this study are supported by the statement (Siregar & Lenni, 2020) that the PjBL-based e-module integrated with *hyperchem* computing media on molecular shape material has been able to support student learning in achieving learning objectives.

In addition, there is additional insight in the form of a link between biotechnology material about Sawi Asin fermentation which is local potential in Kapuas Hulu developed by researchers because the material presented is by the conditions around students so that the PjBL e-module can encourage students' desire to study biology. This is relevant to the results of research (Masihu & Augustyn, 2021) that teaching materials based on local wisdom can be used as teaching materials that can increase students' knowledge of the material studied.

CONCLUSION

The conclusion of the results of this study, namely the PjBL e-module based on the results of research on the nutritional content of Sawi Asin fermentation is feasible to use with an average value of 94.22% media experts, 80.83% material experts, and 87.33% language experts with very feasible criteria. Based on small-scale student responses, the average score was 81.09% with positive criteria. After that, a small revision was made and the average value increased as evidenced by the results of

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student responses on a large scale with an average value of 87.04% with very positive criteria. So the PjBL e-module based on the results of research on the nutritional content of Sawi Asin fermented biotechnology material for class XII SMA is feasible to use in learning.

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