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Tempoyak as a Biotechnology Learning Media: Innovation of Ethnoscience-Based PjBL E-module to Improve Science Literacy and Creativity of Phase E Students

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a b s t r a c t

This research is motivated by the limitations of teaching materials that are less interactive and innovative and the low scientific literacy and creativity of students. The purpose of this study is to develop an ethnoscience-based Project-Based Learning (PjBL) e-module in making *Tempoyak* as a biotechnology teaching material to improve scientific literacy and creativity of Phase E students. The method used is Research and Development (R&D) with a 4D development model (Define, Design, Develop, and Disseminate). The research sample consisted of two classes, namely the experimental class using the ethnoscience-based PjBL e-module and the control class using conventional teaching materials. The effectiveness of the e-module was measured by comparing the results of the pretest and posttest, as well as the creativity questionnaire. The results showed that the developed e-module was effective in improving the scientific literacy and creativity of students. The average posttest score of the experimental class increased significantly compared to the control class. Thus, this e-module can be an alternative innovative teaching material that integrates science with local culture, which can improve scientific literacy and creativity.

1. Introduction

Science and technology are developing rapidly, and this has an impact on the field of education. Technological developments challenge teachers in preparing students to achieve 21st-century skills. Scientific literacy and creativity are some of the 21st-century skills that students must have; the learning process must be centered on students, and teaching and learning activities must be more innovative and creative to achieve the desired skills (Dianti et al., 2023). However, to achieve increased scientific literacy and creativity, there are various challenges in the world of education, one of which is teaching materials that are less innovative, less interest in reading, and a lack of teaching materials that support high-level thinking and creativity through practice questions and assignments, which can lead to low scientific literacy and creativity of students (Andriani et al., 2018).

The 2022 PISA results stated that Indonesia's literacy score had decreased by 12 points from the 2018 PISA results. The results also explain that Indonesian students are 117 points behind the global literacy average score. Scientific literacy is a person's ability to apply their knowledge in identifying questions, constructing new knowledge, providing scientific explanations, drawing conclusions based on scientific evidence, and the ability to develop reflective thinking patterns so that they can participate in addressing issues and ideas related to science (OECD, 2019). In addition to low scientific literacy skills, students' creativity is also relatively low. From the 2023 Global Creativity Index (GCI) data, Indonesia's creativity is among the lowest compared to other countries in the world. Indonesia is ranked 61st among 152 countries (Setiaji et al., 2021). Creativity is the skill of students to come up with new ideas, methods, or models to solve a problem (Astuti & Aziz, 2019).

From the results of interviews with several biology teachers in high schools in Lampung via Google Form, the teaching materials used are printed modules in PDF format, textbooks, and worksheets. The contents of the teaching materials are still in the form of text and images. Some of these schools have not used interactive, innovative, and fun electronic teaching materials as teaching materials. The problems that researchers found in the field were also reinforced by several previous studies that had been conducted in Indonesia regarding the lack of current teaching materials, including research conducted by Noviati et al. (2020), which stated teacher and student books provided by the Ministry of Education and Culture have not been created and developed, and all biology materials use the same learning model (Sari et al., 2020). Meanwhile, according to the teaching materials currently used, they are less interesting and challenging for students to understand, so students are less likely to be able to solve problems in their environment and, thus, are less able to analyze and find solutions to problems that occur.

One of the engaging and interactive teaching materials expected to improve scientific literacy and develop students' creativity based on digital is teaching materials in the form of e-modules. E-modules are considered interesting teaching materials because they contain explanations of the material accompanied by images, videos, audio, and other forms of multimedia (Hilmi et al., 2018). E-modules are teaching materials presented concisely and systematically so that they can be studied by students independently without assistance from educators (Maskur & Safitri, 2021). E-modules can be designed by adding videos and images to the explanation of the material and questions to train students' scientific literacy skills (Menda, 2022). E-modules can also increase students' creativity if the e-module contains exercises or assignments that help students think creatively and implement material on real-life projects and their relevance to learning (Cahyani et al., 2020).

In developing e-modules, it is more effective if integrated with learning models or approaches to achieve the desired learning objectives, such as scientific literacy and creativity of students. One of the learning models that can improve scientific literacy and creativity is the Project-Based Learning (PjBL) learning model. PjBL can improve scientific literacy and creativity because 1) Involves students in complex real-world problems that enable students to define meaningful issues or problems; 2) Requires a process of inquiry, research, planning skills, critical thinking, and problem-solving skills to create a project; 3) Involves students in learning to apply knowledge and skills with varying contexts when working on projects; 4) Provides opportunities for students to learn and practice skills (Melindayani, 2022). E-modules based on ethnoscience encourage teachers and education practitioners to teach biology concepts by considering cultural diversity, local knowledge, and community issues so that students can gain a more relevant understanding and application of the scientific knowledge they learn to be able to apply it in solving problems in everyday life as a form of fostering scientific literacy (Maytrea et al., 2020).

In addition to the PjBL model, there is an approach that supports the PjBL model in improving scientific literacy and student creativity, namely the ethnoscience approach. Integrated ethnoscience learning is a new innovation in the world of education that combines culture with science (Novitasari et al., 2021). Najib (2018) argues that community knowledge of local wisdom in their area can be used and applied in learning, such as making teaching materials. Ahmadi et al. (2019) stated that the integration of ethnoscience into teaching materials can improve student learning outcomes, both cognitive learning outcomes and psychomotor learning outcomes.

The ethnoscience raised in this study is the making of *Tempoyak*, which will be connected to biotechnology material. *Tempoyak* is a processed product of durian fermentation. Durian fermentation into *Tempoyak* is included in lactic acid bacteria fermentation (Arifianti, 2017). The ethnoscience approach to making *Tempoyak* can improve scientific literacy and creativity because the e-module presents problems regarding the factors that must be considered in making *Tempoyak* in order to produce safe and quality *Tempoyak*; from these problems, students are presented with several questions so that students must be able to answer questions regarding the success factors for making *Tempoyak*, solve a problem, and conclude through *Tempoyak* making practicums. From the background that has been explained, this study aims to determine the validity of the e-module project-based learning based on ethnoscience in making *Tempoyak* using biotechnology material that was developed, producing a product in the form of e-module project-based learning based on ethnoscience on making *Tempoyak* on practical biotechnology material and knowing the effectiveness of e-modules, ethnoscience-based project-based learning on making *Tempoyak* on biotechnology material developed to improve scientific literacy skills and creativity of students.

2. Method

The development model in this study uses a Research and Development (R&D) based approach, which is a research method for developing new products (Richey & Klein, 2007), and refers to the 4D development model developed by Thiagarajan (1974). This model consists of 4 stages. development, namely Define (definition), Design (planning), Develop (development), and Disseminate (distribution).

Table 1. 4D Model Development Procedure

Stage	Development Procedure
Define Stage	The initial stage of conducting a needs analysis. The definition or needs analysis stage can be done through field studies and literature studies on teaching materials currently in use.
Design Hold (Design)	Designing a prototype of teaching materials (learning media) that will be developed according to the results of the needs analysis.
Develop Stage	The third stage in the 4D model is a stage to produce a development product. This stage consists of two steps, namely *expert appraisal* accompanied by revision and developmental testing (development trials on a small scale outside the experimental class and control class).
Disseminate Stage (Dissemination)	Stage is the final stage in the development of 4D model learning devices. At this stage, after being tested on a small scale and revised from the results of student input, the product is disseminated or tested on a large scale (experimental class).

The population in this study was all students of class X of SMAN 1 Raman Utara, East Lampung. The sample used in this study was students of classes X1 and X3. The sample was taken using the technique of random sampling. Random sampling technique is a method that is used to select samples from a population at random so that each member of the population has an equal opportunity to be taken as a sample. The effectiveness of the ethnoscience-based PjBL e-module in improving scientific literacy and student creativity will be determined through a comparison of pretest-posttest scores in the control class and the experimental class. For students, creativity will be seen through a comparison of creativity questionnaire scores before and after learning.

This development research uses three types of data collection techniques, namely interviews, research questionnaires, and pretest-posttest. The questionnaires used consisted of a questionnaire for analyzing students' needs in the learning process, a questionnaire for validating materials, a questionnaire for validating media, a questionnaire for assessing product practicality, a questionnaire for validating student worksheets and teaching modules, a questionnaire for assessing student creativity and a questionnaire for assessing the use of e-modules.

The data analysis technique in this study uses qualitative and quantitative data analysis techniques. Qualitative data analysis is used to collect data information in the form of suggestions and input from validators, as well as input and suggestions from teachers and students. Quantitative data analysis is done by analyzing the data. The use of descriptive quantitative data analysis techniques involves calculating the scores obtained in percentage form (Labib, 2019).

Product validation analysis is carried out to measure assessment indicators related to materials and media. In analyzing module validation, the researcher first creates a validation sheet containing statements, then the validator fills out the questionnaire by checking the categories provided based on Likert scale.

Table 2. Validity test assessment questionnaire scale

Suitability level category	Score
Very Suitable	5
In accordance	4
Quite Appropriate	3
It is not in accordance with	2
Totally Inappropriate	1

Source: (Febiharsa et al., 2018)

The score conversion is interpreted into categories based on Table 3.

Table 3. Validity Criteria of Validation Test

Percentage (%)	Validity Criteria
$0 \leq X \leq 25$	Invalid
$25 < X \leq 41$	Less Valid
$41 < X \leq 50$	Quite Valid
$50 < X \leq 75$	Valid
$75 < X \leq 100$	Very Valid

Source: (Irwandani et al ., 2017)

Teaching materials in the form of PjBL e-modules based on ethnoscience are declared theoretically valid if the validity percentage is > 50% (Irwandani, 2017).

Product Trial Analysis

The product usage trial was conducted to determine the practicality of the e-module. This test was practiced by using the e-module in the learning process. To calculate the practicality of the product, the researcher provided a response questionnaire in the form of a product practicality instrument to teachers and students in the experimental class based on the categories provided, with a Likert scale assessment consisting of 5 assessment scores shown in Table 4.

Table 4. Product practicality questionnaire scale

Category	Score
Very Suitable	5
In accordance	4
Quite Appropriate	3
It is not in accordance with	2
Totally Inappropriate	1

Source: (Febiharsa et al., 2018)

The practicality score obtained has the criteria of being very practical if the value is ≥80% (Lestari et al., 2018). To find out the increase in science literacy, a pretest-posttest test was conducted on the experimental class and the control class. The pretest and posttest scores have a score of 5 points for each correct answer, then the pretest-posttest scores of the experimental class and the control class were calculated to find the difference using the N-gain formula. The formula for finding the N-gain value, according to Hake (1999). After the N-gain value is known, the next step is to calculate the average N-gain value. To determine the interpretation category of the N-gain value, see Table 5.

Table 5. *N-gain* Value Interpretation Category

N-gain value	**Interpretation**
$g > 0.7$	Tall
$0.3 \leq g \leq 0.7$	Currently
$G < 0.3$	Low

Source: (Hake, 1999)

After knowing the N-gain value in the experimental class and control class, the next step is to analyze the effectiveness of biotechnology learning using the ethnoscience-based PjBL e-module with the MANOVA test. MANOVA is defined as a statistical technique used to calculate the significance test of mean differences simultaneously between groups for two or more dependent variables. The MANOVA test is carried out if the data meet the required prerequisite tests, namely the multivariate normality test and the homogeneity of the variance-covariance matrix (Syafa, 2022). The normality test is used to determine whether data is normally distributed or not. To test normality in this study, the Kolmogorov-Smirnov test was used. If the significance value $\alpha > 0.05$, then H_0 is accepted and Ha is rejected, which means the data is stated to be multivariate normally distributed. If the data obtained is not normally distributed, then the Mann-Whitney U Test is carried out.

The homogeneity test is performed after the normality test. This test is conducted to obtain information that the research data from each data group does come from a population whose diversity is not much different (Supardi, 2017). Homogeneity testing is analyzed using the SPSS 24.0 application program at the significance level used in this test, namely $\alpha = 0.05$. For the decision criteria in this homogeneous test, if the significance value $\alpha > 0.05$, then H_0 accepted, and Ha is rejected, which means the data is said to be homogeneous. After conducting the prerequisite test, the next step is to conduct a MANOVA test. After the data is normal and homogeneous, a MANOVA test is carried out. The level of significance in the MANOVA test used is 0.05. If the significance value $\alpha \leq 0.05$, then H_0 is rejected and Ha is accepted, which indicates that there is an effectiveness of using ethnoscience-based PjBL e-modules on students' scientific literacy and creativity skills compared to classes that do not use e-modules. The hypothesis in this study is:

H_0: There is no effectiveness in the use of ethnoscience-based PjBL e-modules on students' scientific literacy and creativity skills.

H_a: There is effectiveness in using ethnoscience-based PjBL e-modules on students' scientific literacy and creativity skills.

3. Result and Discussion

Define Stage

The stage of defining or analyzing the research needs is carried out through field studies (teacher interviews and distributing needs analysis questionnaires) and literature studies. A needs analysis Table 6 is presented from the results of field studies and literature studies.

Table 6. Potential issues found

No	Information	Current Module	Required Modules
1.	Previous research literature study	The characteristics of several digital modules currently still consist of text and images and have not followed the development of science and technology, which displays a multimedia touch (Putrawansyah, 2016, p. 41).	Interactive, interesting, and innovative e-modules are needed in accordance with the development of science and technology, and the modules developed must display a multimedia touch. Explanation of the material is not only images and text, but can also be added with learning videos.
		In the current e-module, the evaluation questions and assignments presented do not measure students' scientific literacy skills (Imaningtyas et al., 2016)	An e-module is needed that contains practice questions and assignments to train students' scientific literacy skills.
		Based on the results of a literature study from research conducted by Azizah (2022), the e-module developed has not been integrated with a learning model or approach.	An e-module that is integrated with the learning model is needed because the e-module that is developed will provide maximum results if it contains a learning model or approach that supports student competency.
		Based on the results of a literature study, teachers use teaching materials from the central government, which makes it difficult for students to connect the material with everyday life because the environmental conditions are different (Wero et al., 2021).	An e-module is needed that connects the material with the environment and the daily lives of students.
2.	Field Study	Based on the results of field studies, most biology learning in schools still uses printed books. There are also those who use e-module*s* but they are still less interactive and innovative because the explanation of the material is only in the form of text and images.	An interactive e-module is needed that explains the material, accompanied by easy-to-understand learning images and videos.
		There are no questions or assignments to train students' scientific literacy and creativity.	*An* e-module is needed which contains practice questions and assignments to train students' scientific literacy and creativity.

Design Stage

At this stage there are two stages of product design, namely planning and development. Product design planning consists of 2 aspects, namely planning in terms of material and media aspects that will be used in developing the e-module. Product design planning is presented in Table 7.

Table 7. Product design planning

No	Aspect	Explanation
1.	Material	Biotechnology material phase E
2.	Media	The media design was prepared by researchers based on the results of field studies and literature studies that had been conducted previously. Thus, researchers designed the content and features contained in the e-module *product* to be developed to have the following characteristics: 1) Pay attention to the attractiveness aspects in terms of design, brightness, video, and image resolution in the explanation of the material presented in the e-module . 2) There are questions and assignments to train students' scientific literacy and creativity. 3) Based on the PjBL learning model and ethnoscience approach (making *Tempoyak*), which is connected to biotechnology material. 4) The e-module is in the form of *a* flipbook that can be flipped like a book. 5) 5) Can be accessed via *mobile phone* or other computer devices using a link or QR *code* .

After carrying out product planning, the next stage is developing the product design (designing the layout and multimedia, explaining the material accompanied by pictures and learning videos, adding navigation buttons, integrating the PjBL model and ethnoscience of making *Tempoyak*, the *conversion* stage interactive e-module flipbook).

Figure 1. E-module *cover*

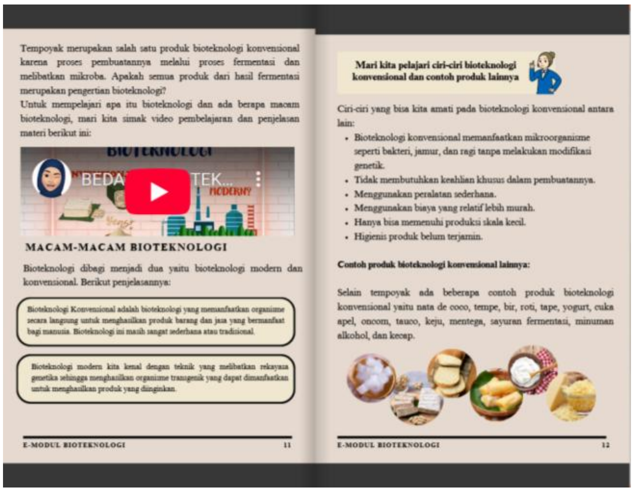

Figure 2. Explanation of the material accompanied by images and videos

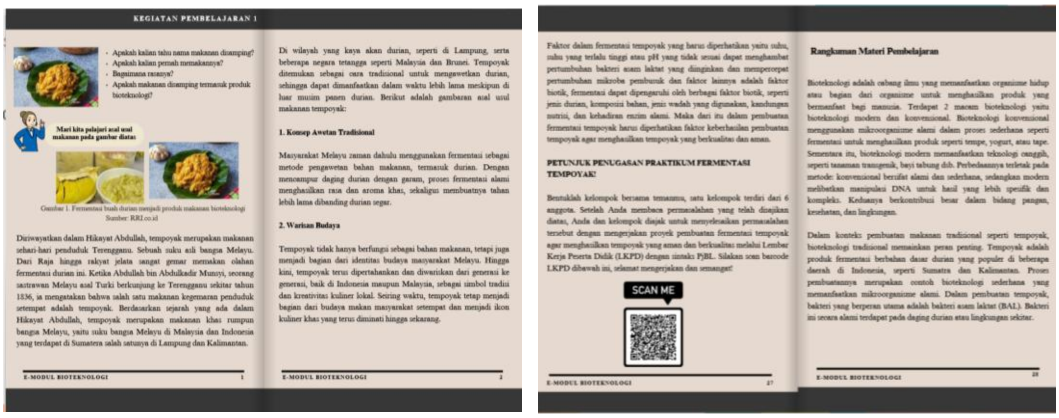

Figure 3. Based on ethnoscience and PjBL assignments

For more details, please see the link (https://heyzine.com/flip-book/33d5ca8af6.html).

Develop Stage

This stage consists of two steps, namely *expert* appraisal accompanied by criticism and suggestions and *developmental testing* (development trials).

Expert Appraisal and Product Revision

The expert validation test involved two lecturers from Yogyakarta State University and one Biology teacher from SMAN 1 Raman Utara to assess the practicality of the product. Validator assessment is presented in Table 8.

Table 8. Validity and practicality test scores

No	Validation	Score (100%)	Category
1.	Media expert (e-module)	96.60	Very valid
2.	Worksheet	89.75	Very valid
3.	Experimental class teaching module	84.00	Very valid
4.	Control class teaching module	82.00	Very valid
5.	Material expert (material and questions on e-module)	76.75	Very valid
6.	Practitioner test (Biology teacher)	95.00	Very practical
	Average	87.35	Very valid and practical

The media expert test aims to validate the suitability of the media display contained in the interactive e-module. In addition, media expert tests were conducted to validate aspects of the cover and content of the e-module, layout, suitability of images and media, the ability to motivate students to learn biotechnology and interactivity. Validation of LKPD aims to validate LKPD from the aspect of appearance, suitability with PjBL syntax, and practice questions and assignments to improve science literacy and creativity. Validation of teaching modules aims to validate teaching modules so that they can be used for the learning process in terms of identity, formulation, and learning objectives, selection of learning materials and methods, activity planning, selection of learning resources, and selection of language. The material expert test aims to validate the suitability of learning outcomes, learning objectives, material feasibility, material truth, presentation aspects and integration with PjBL and Lampung ethnoscience. In addition, the material expert test is also carried out to validate whether there are any misconceptions of the material in the developed e-module. The assessment of product practicality is seen from the effectiveness, usefulness, presentation, content feasibility, efficiency, and language used.

Product Revision

Table 9 shows the results of the e-module assessment by validators and practitioners.

Table 9. Revisions from validators and practitioners

Media Expert	Subject Matter Expert	Practitioner
First, explain the ethnoscience of Lampung, namely the origin of *Tempoyak* food, the differences between Lampung *Tempoyak* and other regions, the definition of *Tempoyak*, including the tools and materials used, the manufacturing process, the success factors for making Tempoyak, and then go into the Biotechnology material.	In the e-module, the definition of modern biotechnology needs to be revised.	Addition of a glossary to the ethnoscience-based PjBL e-module
Learning videos must be easy for students to understand and the material presented must be complete so that students can work on the questions and assignments given.	Learning outcomes need to be adjusted to all learning tools.	
	Some species names have not been italicized.	
	Added biochemical reactions in the explanation of *Tempoyak* fermentation	
	The characteristics of modern biotechnology need to be revised and the tissue culture technique video replaced.	
	Revision of the negative impacts of biotechnology and addition of material explanations about solutions.	

Developmental testing

After the validation and product revision stages, the product will be tested on a small scale by seven students outside the research sample to evaluate the operational trial and see the students' responses to the e-module. Table 10 shows the results of the e-module validity scores in small-scale trials.

Table 10. Small-scale e-module validity scores

Evaluation	Assessment Score (%)	Category
Aspects of interest	85	Very valid
Material aspects	75	Very valid
Average	80	Very valid

Disseminate stage

Stage is the final stage in the development of 4D model learning devices. After the product has been assessed from a small-scale trial, the product is disseminated or tested on a large scale (experimental class).

Large-scale trial

After the e-module is declared valid and practical, the next stage is to implement it in the experimental class using e-module teaching materials that have been developed for biotechnology learning. Large-scale trial data are presented in Table 11.

Table 11. Validity Score Data in Large-Scale Trials

Evaluation	Assessment Score (%)	Category
Aspects of interest	82	Very valid
Material aspects	80	Very valid
Average	81	Very valid

Learning implementation results

All PjBL syntaxes were implemented well in the experimental and control classes. However, there were differences in treatment, namely that the experimental class used the developed e-module, while the control class used printed books that were commonly used by teachers.

Table 12. Learning Implementation Results

Class	Meeting	Steps taken	Total learning steps	Percentage of implementation
Experiment	1st	3	6	100%
	2nd	3		
Control	1st	3	6	100%
	2nd	3		

Results of descriptive analysis of scientific literacy and creativity skills

Students' scientific literacy skills can be measured by a multiple-choice test consisting of 20 questions at the beginning of learning or called a pretest and at the end of learning or called a posttest. The results of the students' science literacy test are shown in Table 13.

Table 13. Results of Students' Science Literacy Skills

Information	Experimental Class		Control Class	
	Pretest	Posttest	Pretest	Posttest
Number of Samples	30.00	30.00	31.00	31.00
Minimum Value	40.00	70.00	40.00	75.00
Maximum Value	90.00	100.00	50.00	80.00
Average	65.00	85.00	45.00	77.50

The results of scientific literacy skills in Table 15 show a comparison of test scores in the experimental class and the control class. The average *pretest* and *posttest scores* of the experimental class were higher than those of the control class. However, from the average results, both classes experienced an increase in scientific literacy skills. Next, the analysis was carried out using N-Gain. N-Gain is used to determine how much influence the ethnoscience-based PjBL e-module of *Tempoyak* making on biotechnology material has in improving scientific literacy and student creativity. Table 14 shows the results of the N-Gain values of science literacy for the experimental and control classes.

Table 14. N-Gain value of science literacy of experimental and control classes

Class	*N-gain*	Interpretation	
Experiment	0.5	$0.3 \leq g \leq 0.7$	Currently
Control	0.2	$g < 0.3$	Low

Based on Table 14, the comparison of pretest and posttest of science literacy in the experimental class is higher than the control class. The experimental class gets an N-gain of 0.5 with a moderate interpretation. While the control class gets an N-gain of 0.2, with a low interpretation. Student creativity can be measured by using a creativity assessment questionnaire at the beginning of learning, or called a pretest, and at the end of learning, or called a posttest. The data from the student creativity questionnaire are shown in Table 15.

Table 15. Student creativity assessment results

Information	Experimental Class		Control Class	
	Pretest	Posttest	Pretest	Posttest
Number of Samples	30.00	30.00	31.00	31.00
Minimum Value	76.00	82.00	78.00	80.00
Maximum Value	83.00	88.00	82.00	86.00
Average	79.50	85.00	80.00	83.00

The results of the creativity assessment in Table 17 show a comparison of pretest scores that are not that far apart between the experimental class and the control class. The experimental class got a score of 79.5 while the control class got 80. However, the average posttest score of the experimental class was higher than that of the control class. From the average results, both classes experienced an increase in creativity. Next, the analysis was carried out using N-Gain. Table 16 shows a comparison of N-Gain values for creativity in the experimental and control classes

Table 16. N-Gain value of experimental and control class creativity

Class	N-gain	Interpretation	
Experiment	0.3	$0.3 \leq g \leq 0.7$	Currently
Control	0.2	$g < 0.3$	Low

In Table 16, the comparison of pretest and posttest creativity in the experimental class is higher than in the control class. The experimental class gets an N-gain of 0.3 with a moderate interpretation. While the control class gets an N-gain of 0.2, with a low interpretation. From the results of the N-Gain values of scientific literacy and creativity in both the experimental and control classes, it shows that the N-Gain value of the experimental class is higher so it can be concluded that the e-module has an effect on increasing scientific literacy and creativity of students.

This is because the e-module presents complete material, and there are practice questions and assignments to train students' scientific literacy and creativity skills. In the e-module, problems are also presented contextually, then students, together with their groups, solve the problems by working on a *Tempoyak*-making project. Furthermore, students must also answer questions and conclude the results of the practicum carried out in the LKPD. Strengthened by previous research conducted by (Kimianti et al., 2019) that the integrated ethnoscience e- module in problem-based learning provides opportunities for students to find their own concepts with various activities such as finding solutions to problems that have been provided so that students have a lot of knowledge and can improve students' scientific literacy skills.

The Effectiveness of E-module on Science Literacy and Creativity Based on the Manova Test Normality Test of Experimental and Control Classes

Kolmogorov-Smirnov normality test is part of the classical assumption test, meaning that before conducting statistical analysis for hypothesis testing, the research data must be tested for normal distribution. If the significance value (Sig.) Is greater than 0.05, the research data is normally distributed. Table 17 shows the normality test of the experimental class and the control class.

Table 17. Results of the normality test for the experimental and control classes

Variables	Class	One Sample Kolmogorov Smirnov Test			Information
		Statistics	**Df**	**Sig**	
Science Literacy	Pre_Experiment	0.123	30	0.200	Data distribution is normally distributed
	Post_Experiment	0.140	30	0.138	
	Pre_Control	0.151	30	0.081	
	Post_Control	0.136	30	0.165	
Creativity	Pre_Experiment	0.120	30	0.200	Data distribution is normally distributed
	Post_Experiment	0.148	30	0.094	
	Pre_Control	0.146	30	0.100	
	Post_Control	0.125	30	0.200	

Homogeneity Test of Experimental and Control Classes

After conducting a normality test, the next step is to conduct a homogeneity test with the help of SPSS 24 using the Levene test. Homogeneity test according to (Putri et al., 2018) functions to find groups of sample data that can be said to be homogeneous. The criteria for the homogeneity test are that the data can be declared homogeneous if the significance value is > 0.05, and is not said to be homogeneous if the significance value is < 0.05.

Table 18. Results of the homogeneity of variance test in the experimental and control classes

Test of Homogeneity of Variance					
		Levene Statistics	**df1**	**df2**	**Sig.**
Science Literacy	Based on Mean	2.225	1	59	.141
	Based on Median	.872	1	59	.354
	Based on Median and with adjusted df	.872	1	57,808	.354
	Based on trimmed mean	1,901	1	59	.173
Creativity	Based on Mean	3.948	1	59	.062
	Based on Median	1,588	1	59	.213
	Based on Median and with adjusted df	1,588	1	56,906	.213
	Based on trimmed mean	3.450	1	59	.068

Based on Table 18, the results of the homogeneity test of scientific literacy show that the Mean significance result is 0.141> 0.05, so it can be concluded that the variance of the *posttest data* of the experimental and control classes is not the same or homogeneous. The results of the creativity homogeneity test show that the Based on Mean significance result is 0.062> 0.05, so it can also be concluded that the variance of the *posttest data* of the experimental and control classes is not the same or homogeneous. The last test before the MANOVA test is the multicollinearity test using the Pearson correlation formula ($p < 0.05$). There is a relationship between the independent variables. The multicollinearity test is used to determine whether there is a high or perfect correlation between the independent variables in the regression model. Table 19 shows multicollinearity test results.

Table 19. Multicollinearity test

Correlations			
		Science Literacy	Creativity
Science Literacy	Pearson Correlation	1	.425 *
	Sig. (2-tailed)		.021
	N	61	61
Creativity	Pearson Correlation	.496 *	1
	Sig. (2-tailed)	.021	
	N	61	61

*. Correlation is significant at the 0.05 level (2-tailed).

In Table 19, the Sig. (2-tailed) value <0.05 is 0.021 <0.05, so it can be concluded that there is a correlation between the 2 dependent variables. In Table 20, the Pearson Correlation on scientific literacy and creativity is 0.425 and 0.496, with the degree of relationship between these two variables being moderately correlated, so the higher the scientific literacy ability, the more it will affect the level of creativity.

After the data is normally distributed and homogeneous, it can be continued with the MANOVA test. MANOVA test is used to determine the effectiveness of the use of ethnoscience-based PjBL e-module*s* in improving students' scientific literacy and creativity. The results of the MANOVA test show that the significance value of $\alpha \leq 0.05$, then H_0 is rejected and H_a is accepted, which indicates that there is effectiveness in the use of ethnoscience-based PjBL e-module*s* on students' scientific literacy and creativity. Table 20 shows the MANOVA test results.

Table 20. A test results

Multivariate Tests [a]				
Effect		Value	Hypothesis df	Sig.
Intercept	Pillai's Trace	.999	4.000	.000
	Wilks' Lambda	.001	4.000	.000
	Hotelling's Trace	1983.388	4.000	.000
	Roy's Largest Root	1983.388	4.000	.000
Group	Pillai's Trace	.337	4.000	.000
	Wilks' Lambda	.663	4.000	.000
	Hotelling's Trace	.509	4.000	.000
	Roy's Largest Root	.509	4.000	.000

a. Design: Intercept + Group

b. Exact statistics

Ethnoscience-based PjBL e-modules can improve students' scientific literacy and creativity. Project Based Learning is a learning model that uses projects or activities as media. PjBL is an innovation in learning models that involve high-level thinking processes (Brunner & Sievi, 2017). Project Based Learning is a learning method that uses problems as the first step in collecting and integrating new knowledge based on their experiences in real activities. This learning model requires students to use all their potential in solving problems. The existence of activities to design and create a project will support the development of students' scientific literacy and creativity. The results of the study (Melindayani, 2022) show that the Project Based Learning learning model can influence scientific literacy skills because it can provide students with the freedom to think actively and creatively in completing projects and students can make decisions creatively in solving problems. The ethnoscience approach to making *Tempoyak* can improve scientific literacy and creativity because the e-module presents problems regarding factors that must be considered in making *Tempoyak* in order to produce safe and quality *Tempoyak*, from these problems students are presented with several questions so that students must be able to answer questions regarding the success factors for making *Tempoyak*, solve a problem and conclude through *Tempoyak* making practicums. From the *Tempoyak* making practicum activities, it is also expected that students can think fluently in solving problems, finding answers, choosing ways to make *Tempoyak* successfully according to creativity indicators.

The N-Gain value from the pretest and posttest results of the experimental and control classes showed that the comparison of the pretest and posttest in the experimental class was higher than the control class. The experimental class obtained an N-gain of 0.5 with a moderate interpretation. While the control class obtained an N-gain of 0.2 with a low interpretation, this shows that the e-module has an effect on increasing scientific literacy. The comparison of the pretest and posttest of the creativity assessment in the experimental class was also higher than the control class. The experimental class obtained an N-gain of 0.3 with a moderate interpretation. While the control class obtained an N-gain of 0.2 with a low interpretation, this shows that the e-module also has an effect on increasing student creativity. After calculating the N-Gain value, the next stage is the normality and homogeneity test as a requirement before conducting the MANOVA test.

From the results of the normality test of the experimental and control classes, the significance value is > 0.05 so that the distribution of data for the experimental and control classes is normally distributed. If the data is normal, the homogeneity test can be continued. The homogeneity test of scientific literacy shows the results based on the Mean significance of 0.141> 0.05. The results of the creativity homogeneity test show that the Based on Mean significance of 0.062> 0.05, so that it can be concluded that the variance of the *posttest data* of the experimental and control classes is not the same or homogeneous. In the multicollinearity test table, the Sig. (2-tailed) value <0.05 is 0.021 <0.05, so it can be concluded that there is a correlation between scientific literacy and creativity. In *the Pearson Correlation* of scientific literacy and creativity, it is 0.496 with the degree of relationship between these two variables, namely moderate correlation and the form of relationship between these two variables is positive, which means that the higher the scientific literacy ability, the higher the level of creativity. The last test is the MANOVA test, which shows that the significance value $\alpha \leq 0.05$, then H0 is rejected and Ha is accepted, which shows that there is effectiveness in using the ethnoscience-based PjBL e-module on biotechnology material on students' scientific literacy and creativity skills.

Ethnoscience-based PjBL e-module on *Tempoyak* making can be used for constructivist learning. Constructivist learning theory emphasizes that knowledge is actively constructed by students through direct experience, reflection, and interaction with the surrounding environment and culture. The PJBL approach in e-modules encourages students to actively conduct investigations, experiments, discussions, and problem-solving. *Tempoyak*-making activities, for example, provide space for students to experiment, observe changes, and draw scientific conclusions, as emphasized in constructivist theory that learning occurs through direct interaction with the environment and social collaboration. By combining constructivist theory in the development of ethnoscience-based PjBL e-modules on *Tempoyak* making, students not only build a meaningful understanding of scientific concepts, but also develop their scientific literacy and creativity through direct experience, critical thinking, and problem solving based on local culture.

4. Conclusion

It has been implemented based on research on developing the ethnoscience-based PjBL e-module to make *Tempoyak* on biotechnology material to improve phase E students' scientific literacy and creativity. Project-based learning e-module product for making *Tempoyak* is valid for use in biotechnology learning for phase E students. Project-based learning e-module product of *Tempoyak* making is used for biotechnology learning for phase E students. Project-based learning e-module product is effectively used for biotechnology learning for phase E students so that it can improve scientific literacy and creativity. The teaching materials developed are an e-module project-based learning based on ethnoscience of making *Tempoyak* on biotechnology material. Further research is expected to develop e-modules on other biology materials that are more innovative and interesting. The teaching materials developed are an e-module project-based learning based on the ethnoscience of making *Tempoyak* on biotechnology material to improve science literacy and creativity. Further research is expected to develop e-modules based on ethnoscience from other regions that can be connected to biology material and measure other learning improvements. Implementing e-module PjBL based on ethnoscience has been proven effective in improving students' science literacy and creativity. Therefore, educators are expected to be able to create more innovative and engaging teaching materials in order to achieve the desired learning objectives.

References

Arifianti, K. K. Y. (2017). Peran Pendidikan Dan Pengetahuan Ilmu Kimia Dalam Mengembangkan Potensi Pengawetan (Tempoyak Atau Pakasam) Bahan Nabati Dan Hewani Lokal Daerah Kalimantan Tengah. *Jurnal Ilmiah Kanderang Tingang, 8*(1), 1-7.

Astuti, R., & Aziz, T. (2019). Integration of Early Childhood Creativity Development in Kanisius Kindergarten Sorowajan Yogyakarta. *Jurnal Obsesi: Journal of Early Childhood Education, 3*(2), 294. https://doi.org/10.31004/obsesi.v3i2.99

Azizah. (2022). Development of Interactive Digital Module Based on Sigekh Pengunten Dance for Junior High School Students on Human Movement System Material. University of Lampung.

Brunner, H., & Sievi, R. (2017). Asymmetric catalyses. XXXIII. New optically active phospholanes derived from tartaric acid. *Journal of Organometallic Chemistry, 328*(1–2), 71–80. https://doi.org/10.1016/S0022-328X(00)99768-7

Cahyani, AEM, Mayasari, T., & Sasono, M. (2020). Effectiveness of E-module Project Based Learning Integrated with STEM on Creativity of Vocational High School Students. Scientific Journal of Physics Education , 4 (1), 15. https://doi.org/10.20527/jipf.v4i1.1774

Dianti, SAT, Pamelasari, SD, & Hardianti, RD (2023). Project-Based Learning Approach with STEM Approach to Improve Students' Science Literacy Skills. National Science Seminar XIII, 432–442.

Febiharsa, D., Sudana, IM, & Hudallah, N. (2018). Functionality Testing (Blackbox Testing) of Batik Professional Certification Institute Information System (SILSP) with AppPerfect Web Test and User Test. *Joined Journal (Journal of Informatics Education), 1*(2), 117. https://doi.org/10.31331/joined.v1i2.752

Hake, R.R. (1998). Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses. *American Journal of Physics, 66*(1), 64–74. https://doi.org/10.1119/1.18809

Hilmi, R. Z, Hurriyati, R., & Lisnawati. (2018). Interactive multimedia learning module based on Adobe Director on operating system subjects for vocational high schools, *3*(2), 91–102.

Imaningtyas, C. D., Karyanto, P., Nurmiyati, N., & Asriani, L. (2016). Penerapan e-module berbasis problem based learning untuk meningkatkan literasi sains dan mengurangi miskonsepsi pada materi ekologi siswa kelas x mia 6 sman 1 karanganom tahun pelajaran 2014/2015. *Bioedukasi: Jurnal Pendidikan Biologi*, *9*(1), 4-10.

Irwandani, I., Latifah, S., Asyhari, A., Muzannur, M., & Widayanti, W. (2017). Modul digital interaktif berbasis articulate studio'13: pengembangan pada materi gerak melingkar kelas x. *Jurnal Ilmiah Pendidikan Fisika Al-Biruni*, *6*(2), 221-231.

Labib, U. A., & Yolida, B. (2019). Development of an Android-based Application Integrated with a Website as Biology Learning Media. *Bioterdidik Journal, 7*(5), 33–42.

Lestari, L., Alberida, H., & Rahmi, Y. L. (2018). Validitas dan praktikalitas lembar kerja peserta didik (LKPD) materi kingdom plantae berbasis pendekatan saintifik untuk peserta didik kelas X SMA/MA. *Jurnal Eksakta Pendidikan (JEP)*, *2*(2), 170-177.

Marta, H., Fitria, Y., Hadiyanto, H., & Zikri, A. (2020). Penerapan pendekatan contextual teaching and learning pada pembelajaran IPA untuk meningkatkan hasil belajar dan motivasi belajar siswa sekolah dasar. *Jurnal Basicedu*, *4*(1), 149-157.

Maytrea, F. I., Namirah, I., & Solfarina, S. (2020). Development of ethnosains-based learning module theme acid and base for senior high school class XI. *JCER (Journal of Chemistry Education Research)*, *4*(1), 16-22.

Menda, T. (2022). PhET Simulation Based e-module Design on Mechanical Energy (Doctoral dissertation).

Melindayani, S. (2022). The Influence of Project-Based Learning Model on Science Literacy Skills of Grade V Students of Telkom Elementary School Makassar. *Handayani Journal, 13*(1), 1. https://doi.org/10.24114/jh.v13i1.35821

Najib, K. (2018). Ethnoscience Study of Roof Tile Making Process as Additional Teaching Material for Integrated Science Lessons. *Journal of Physics Learning Research, 9* (2), 98–103. https://doi.org/10.26877/jp2f.v9i2.3107

Novitasari, D., MS, AT, Hamdani, D., Junaidi, J., & Arifin, S. (2021). Development of Geogebra-Based Student Worksheets to Improve Understanding of Mathematical Concepts. *Journal of Mathematics Education and Science (JES-MAT), 7*(1), 1–16. https://journal.uniku.ac.id/index.php/JESMath/article/view/3916

OECD (2023). PISA 2022 Results (Volume I): The State of Learning and Equity in Education. Paris: OECD Publishing. https://doi.org/10.1787/53f23881-en

Richey, R. C., & Klein, J. D. (2014). *Design and development research: Methods, strategies, and issues*. Routledge.

Setiaji, K., Muktiningsih, S., & Farliana, N. (2021). The Influence of Learning Independence on Critical Thinking Skills Intervened by Learning Motivation in Economic E-learning. *JEKPEND (Journal of Economics and Education), 4*, 56–63. https://doi.org/10.26858/jekpend.

Sari, R. P., Zuardi, Z., Reinita, R., & Zikri, A. (2020). Penggunaan Model Problem Based Learning terhadap Hasil Belajar dalam Pembelajaran PKn di Sekolah Dasar. *Jurnal Basicedu*, *4*(1), 221-227.

Supardi, U. S. (2017). Application of Statistics in Research (A More Comprehensive Concept of Statistics). Change Publication.

Thiagarajan, S. (1974). Instructional development for training teachers of exceptional children: A sourcebook.