



## Development of E-Module Based on Guided Inquiry Learning (GIL) Integrated Ethnoscience Tape Uli Betawi to Improve Science Literacy of Junior High School Students

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### ABSTRACT

This research resulted in an E-module based on Guided Inquiry Learning (GIL) integrated ethnoscience tape uli Betawi to improve the science literacy of Junior High School students. The aim of the study was to determine the feasibility and effectiveness of ethnoscience e-module to improve science literacy of junior high school students. ADDIE development model was used with five stages: Analyze, Design, Development, Implementation, and Evaluation. The research data were taken using a questionnaire and test method. The analysis stage aims to obtain information as reference material for product development. The design stage is carried out the development of E-module content and storyboards by adjusting the concept map of the material that will be used to produce the draft product. The development stage involves expert validation consisting of expert lecturers and teachers as science learning practitioners. The validation results showed that e-module was suitable for use in classroom learning, with valid results in terms of media, language, learning and material aspects. The improvement in science literacy was calculated using the N-gain test, with moderate results for experimental class and low results for control class. Therefore, ethnoscience e-module was deemed feasible and effective in improving science literacy of junior high school student.

## 1. Introduction

Science literacy among students in Indonesia (383) is lower than the world average (485), placing Indonesia 69th out of 81 countries participating in PISA 2022 (OECD, 2023). Indonesia still ranks lower than most ASEAN countries and some Latin American countries. This shows that most schools in Indonesia have not implemented learning that leads to the development of student science literacy

(Suprayitno, 2019). The factor that causes the students' scientific literacy ability to be not greatest is that according to students' the questions given on the scientific literacy test are more difficult than the exam questions that giving by the teacher. This response is because students do not know about PISA characteristic questions and also the teacher's lack of knowledge about the development of scientific literacy so that students do not know information about PISA and the characteristics of the PISA questions (Andira et al., 2026).

Based on the needs analysis, data on students' science literacy skills is still relatively low. The data was collected through multiple-choice and essay-type science literacy tests administered during school observations. Interviews with science teachers also revealed that teachers lack the ability to train students in science literacy due to limited available media. Teachers also have not maximized the use of local wisdom in learning. Therefore, it is necessary to make gradual and continuous improvements to science learning in schools.

Ethnoscience is a strategy for creating a learning environment by incorporating culture into science learning methods that can benefit students' lives (Ningsih et al., 2022). Ethnoscience-based science learning is learning that reconstructs indigenous knowledge into scientific knowledge (Wae and Kaleka, 2022). Ethnoscience-based learning is in line with the essence of learning, which is to understand material concepts and apply them in real life. One of the efforts that can be made in ethnoscience-based learning is to develop ethnoscience-based teaching materials (Fitriyah et al., 2026)

Ethnoscience learning can be integrated into various learning models, such as contextual, inquiry, problem-based, and project-based learning (Jufrida et al., 2024). The inquiry learning model places learning in the investigation of complex problems or phenomena with an emphasis on engaging in learning activities. However, it is not limited to the process of asking questions and investigating them with empirical data (Wen et al., 2020). The Guided Inquiry Learning (GIL) model can enhance science literacy skills in science concepts due to its focus on student-centered learning (Rahminawati & Andromeda, 2025).

Based on observations, Betawi tape uli is still widely found as a traditional food among communities in the South Tangerang City area. Tape uli consists of two foods, namely black or white sticky rice tape and uli. Black or white sticky rice tape is mixed before processing (steaming, fermentation, etc.) and packaged in banana leaves. Uli is white sticky rice that is steamed and finely pounded to form a sticky, chewy, and dense dough. When eaten together, it produces a sweet and sour taste (from the sticky rice) and a savory taste (from the uli). Based on research conducted by Yohana et al. (2025), the use of local wisdom-based e-modules has proven effective in improving conceptual understanding and digital literacy.

According to Solheri et al. (2022), efforts to improve science literacy in Indonesia can be done through ethnoscience-based learning because it can design learning experiences that integrate culture as part of the learning process. By integrating ethnoscience, science learning becomes more contextual and meaningful, because

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students can directly see the application of scientific concepts in local cultural practices. Based on the above explanation, the aims of the study were to determine the feasibility and effectiveness of ethnoscience e-modules to improve the science literacy of junior high school students.

## **2. Methodology**

### ***Research Design***

This study was conducted using Research and Development (R&D) with ADDIE development model. The implementation of this research consists of three stages, namely; analysis stage, design and development stage, and implementation and evaluation stage. This study evaluates the validity and effectiveness of the use of ethnoscience e-module to improve students' science literacy. The analysis stage is carried out by analyzing learning problems, student characteristics, and initial analysis of students' science literacy. In the design and development stage, the e-module design was drafted, adjustments were made to the e-module based content integrated with Betawi tape uli ethnoscience made the e-module in the form of Flipbook, the product was validated by experts, and the product was revised based on the validation results. The e-module has been declared suitable for use in next step. The implementation stage involved testing the product to determine the effectiveness of the e-module in improving students' science literacy. There were two classes (control and experimental) used in the large-scale trial. The research procedure is illustrated in Figure 1.

### ***Participants***

A medium-scale trial in the development stage used one experimental class with 32 ninth grade students. The implementation stage, or large-scale trial, was conducted with two ninth-grade classes, each with 34 students. One class used the e-module on ethnoscience as the experimental class, while the other class used the teaching media used by the school as the control class. The research procedure is illustrated in Figure 1.

### ***Instruments***

The instruments used in this study consisted of interview guidelines, questionnaires and tests. Interview guidelines are used during the analysis phase to obtain data on learning problems and student characteristics. The use of questionnaires with a Likert scale of 1 to 4 is given during validation by experts. Mixed questionnaire with a combination of closed and open questions. Science literacy test is used as pretest and posttest of learning using e-module.

### ***Data Collection***

Data collection methods include interviews, documentation, questionnaires and tests. Interviews were conducted with science teachers at the analysis stage in order

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to determine the problems that exist in schools. Questionnaires were used for product validation conducted by several experts assessing the feasibility of the e-module. Science literacy test was given to ninth grade students and the results were used N-gain test to determine the effectiveness of e-module in improving students' science literacy.

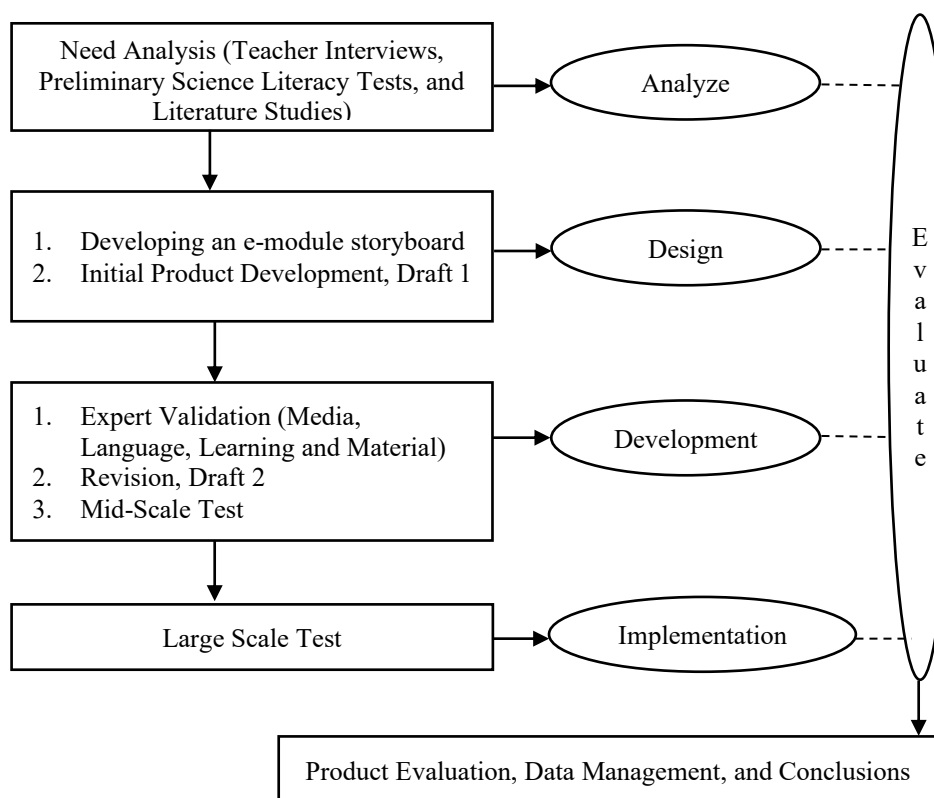


Figure 1. Research Procedure

### Data Analysis

Data analysis in this study consisted of e-module feasibility analysis and e-module effectiveness analysis. E-module feasibility analysis was conducted based on product validation by experts using the V formula with a Likert scale. E-module effectiveness analysis used the N-gain test. The N-gain test reflects how effectively the developed e-module can improve students' science literacy. Validators provide assessments in the form of improvement suggestions and checklists using a Likert scale of 1 to 4, with the criteria being very bad = 1, bad = 2, good = 3, and very good = 4. Aiken validity is used to calculate the results of validator assessments for e-module feasibility. Aiken validity is shown in Equation 1.

$$v = \frac{\sum s}{n(c-1)}$$

Description:

- v : Aiken index  
s :  $r - l_o$

- $l_o$  : Lowest rating number or 1
- $c$  : Highest rating number or 4
- $r$  : The number of ratings given by the validator

Eligibility criteria based on the results of validity can be seen in Table 1

Table 1. Interpretation Coefficient Aiken's V

Score	Criteria
$V_{count} > V_{table}$	Good
$V_{count} < V_{table}$	High
$V_{count} = V_{table}$	Mid

Source: Azwar (2018)

The effectiveness test of learning media is a process to measure the extent to which learning media succeeds in achieving the specified learning objectives (Jafnihirda et al., 2023). Analysis of the increase in students' science literacy was conducted using SPSS 25 software to test homogeneity and normality as well as the T-test. The test treatment requirement was after the normality and homogeneity tests were conducted. The normality test used the Shapiro Wilk test because the number of data was less than 50 samples. The normality test hypothesis was:  $H_0$ : The population of a sample is normally distributed;  $H_1$ : The population of a sample is not normally distributed.

Criteria for test decision making:

- a) If Sig (p) < 0.05, then  $H_0$  is rejected, the data is not normally distributed.
- b) If Sig (p) > 0.05, then  $H_0$  is accepted, the data is normally distributed.

The homogeneity test aims to determine whether the population is homogeneous or not in the research sample. The test used is the Levene Test. The research hypothesis proposed is:  $H_0$ : The variation between the experimental and control groups is homogeneous;  $H_1$ : The variation between the experimental and control groups is not homogeneous.

Criteria for test decision making:

- a) If Sig. 2-tailed < 0.05, then  $H_0$  is rejected, the variation between groups is not homogeneous.
- b) If Sig. 2-tailed > 0.05, then  $H_0$  is accepted, the variation between groups is homogeneous.

The dependent T-test (paired sample t-test) is used after mid-scale test. Paired samples are the same subjects but experience different treatments (Putri et al., 2023). The research hypotheses proposed are:  $H_0$  : There is no difference in the mean between the pretest and posttest after the use of e-module;  $H_1$  : There is a difference in the mean between the pretest and posttest after the use of e-module.

Criteria for test decision making:

- a) If Sig. 2-tailed < 0.05, then  $H_0$  is rejected.

b) If Sig. 2-tailed > 0.05, then  $H_0$  is accepted and  $H_1$  is rejected.

The N-Gain test is a process of normalizing the increase in scores obtained from the pretest and posttest results. The purpose of calculating N-Gain is to see the shift in the retention ability scores of students after participating in the learning process. The test is carried out by calculating the difference between the pretest and posttest scores in the control and experimental classes (Kahfi et al., 2025). The assessment analysis was conducted using N-gain to determine the improvement in science literacy. These results reflect how effective the developed e-module is in improving students' science literacy. The N-gain test calculation uses Equation 2.

$$\text{N-Gain} = \frac{\text{Posttests Score} - \text{Pretest Score}}{\text{Maximal Score} - \text{Pretest Score}}$$

Table 2. Criteria for N-Gain Test

N-gain Score	Criteria
$G < 0,3$	Low
$0,3 \leq G \leq 0,7$	Mid
$G > 0,7$	High

Source: Dewi et al. (2021)

### 3. Results and Discussion

This development research produced an ethnoscience e-module designed for junior high school students to learn about biotechnology and physical and chemical changes. The use of local Betawi wisdom, namely tape uli, is a distinctive feature of this product. The traditional food processing method uses fermentation and causes changes in the food, making this e-module suitable for teaching biotechnology and physical and chemical changes as learning objectives. Through this e-module, students are invited to understand scientific concepts in a more contextual way because the material taught is relevant to their everyday lives. The following are the results obtained from the development process.

#### *Analyze Stage*

This stage is carried out to analyze the necessary information by identifying existing problems for product development. The analysis stage includes interviews with science teachers and preliminary science literacy tests for students. The analyses conducted are learning problem analysis, student characteristics, and preliminary science literacy analysis for students. The findings from the analysis stage include: 1) Limitations of the media used by teachers in learning. 2) Students' science literacy skills are rarely trained. 3) Teachers have not maximized the use of local wisdom in learning. 4) Students preliminary science literacy test results are relatively low. Therefore, teaching materials that integrate local wisdom into science education are needed to improve students' science literacy. The application of local wisdom-based learning can improve students' science literacy in content, context, and process (Nofiana and Julianto, 2018).

## *Design Stage*

The design stage involved designing an ethnoscience e-module that produced a draft e-module. The initial e-module design contained a storyboard that was used as a reference in developing the e-module. Product design 1 (draft 1) was in the form of an initial e-module design in Canva Education. Draft 1 of the ethnoscience e-module can be seen in Figure 2.



Figure 2. Draft 1 Ethnoscience e-Module

## *Development Stage*

This development research produced an ethnoscience e-module designed for junior high school students to learn about biotechnology and physical and chemical changes. The use of local Betawi wisdom, namely tape uli, is a distinctive feature of this product. The traditional food processing method uses fermentation and causes changes in the food, making this e-module suitable for teaching biotechnology and physical and chemical changes as learning objectives. Through this e-module, students are invited to understand scientific concepts in a more contextual way because the material taught is relevant to their everyday lives. Learning with contextual can make learning becomes more meaningful and real, more exciting and not boring, and learning will be more productive (Hidayati et al., 2023). The following are the results obtained from the development process.

The Draft 1 that has been developed is validated by validators or experts. Validation is carried out to obtain scores and input regarding the e-module in accordance with the criteria developed. The results of this process are used as a basis for making improvements before field testing (mid-scale and large-scale testing). The feasibility assessment of the e-module is carried out by experts consisting of lecturers and science teachers. Validators assess the e-module in aspects of media, language, material, and learning. Validators also assess the science literacy test used in field trials. The results of the validation of each aspect can be seen in Table 3.

Table 3. Aiken E-Module Ethnoscience Validity Score

Assessment Aspects	Validation Score	Decision
Media	0,85	Valid
Language	0,83	Valid
Learning and Material	0,86	Valid

Suggestions from experts were used as material for improving the e-module, resulting in draft 2 of the e-module. E-module that has a very good level of feasibility is then declared eligible for use in the learning process because it can make learning activities effective (Nyoman et al., 2022). Mid-scale test aim to test ethnoscience e-module under actual conditions. The sample used was one ninth grade class with 32 students. Before using the e-module in learning, students were given a pretest to measure their initial condition of students' scientific literacy. Learning was conducted in two meetings and ended with a post-test in the last meeting. The normality prerequisite test was performed using Shapiro Wilk with the results shown in Table 4.

Table 4. Normality Test Results During Mid-Scale Testing

Science Literacy	Sig.	Decision
Pretest	0,42	Normal
Posttest	0,07	Normal

Table 4 shows a sig. value  $> 0.05$ , indicating that the pretest and posttest are normally distributed. Normality tests are typically used to measure ordinal, interval, or ratio scaled data. If the analysis uses parametric methods, then the normality requirement must be met, namely that the data comes from a normal distribution. If the data is not normally distributed, parametric statistics cannot be used; therefore, nonparametric statistics must be used (Nurhaswinda et al., 2025). The one paired sample t-test was used to determine the significant difference in the effect of using the e-module, and the N-gain test was used to determine the increase in science literacy. The results of the one paired sample t-test are shown in Table 5.

Table 5. Paired Sample T-Test Result

Variable	Test	df	Sig.	Decision
Science Literacy	Paired T (Pre-Post)	31	0,000	Significant Difference

Table 5 shows that the sig value is  $< 0.05$ , it can be said that there is a significant difference in students' science literacy before and after using e-module. The t-test is used for interval or ratio scaled data and assumes that the data is normally distributed. The purpose of a paired sample t-test or dependent sample t-test is to compare the means of two measurements from the same or related groups. It is often used to measure changes before and after treatment (Wantara et al., 2025). The amount of increase in science literacy of students is shown based on the table of N-gain results in Table 6.

Table 6. N-Gain Test Results During Mid-Scale Testing

Science Literacy Dimennsion	N-gain Dimension	N-gain
Knowledge	0.66	
Competence	0.64	0.63 (Moderate)
Context	0.58	

Table 6 shows that the increase in science literacy of 0.63 is categorized as moderate. The increase of science literacy in the knowledge dimension is 0.66 with moderate category, the increase of competence dimension is 0.64 with moderate category and the increase of context dimension is 0.58 with moderate category. The N-gain results show that the use of e-modules in mid-scale test classes improves students' science literacy.

### **Implementation Stage**

The implementation stage used two ninth-grade classes as experimental and control class. The experimental class used the ethnoscience e-module, while the control class used teaching materials from the school. Normality and homogeneity tests are performed first. The Normality Test is a test conducted with the aim of assessing the distribution of data in a data group or variable, whether the data distribution is normal or not. The Normality Test is useful for determining whether the collected data is normally distributed or taken from a normal population (Nuryami et al., 2024). If this assumption of normality is not met, the results of parametric statistical analysis may be biased and invalid, which could lead to incorrect conclusions and inappropriate decisions (Manggaberani & Fajri, 2025). The normality test results of both classes are shown in Table 7.

Table 7. Normality Test Results During Large Scale Testing

Class	Science Literacy	df	Sig.	Decision
Experimental	Pretest	34	0.07	Normal
	Posttest	34	0.08	Normal
Control	Pretest	34	0.70	Normal
	Posttest	34	0.11	Normal

Normality test of science literacy test using Shapiro Wilk test and a sig. value > 0.05, was obtained, indicating that the science literacy tests of the control and experimental classes were normally distributed. Homogeneity testing can be performed using Levene's Test. The main purpose of this test is to see how much variance there is between two or more different data sets. From the results of this data testing, we can see whether the data is homogeneous or not. To conclude whether data is homogeneous or not, the results can be determined from the significance value (Yuliana et al., 2023). The homogeneity test is shown in Table 8.

Table 8. Homogeneity Test Results During Large Scale Testing

Science Literacy	Levene Statistic	Sig.	Decision
Pretest	3,77	0,10	Normal
Posttest	2,59	0,11	Normal

Homogeneity test results obtained a sig. value  $> 0.05$  can be interpreted that the variation of experimental or control science literacy data is homogeneous or comes from the same population. If the data is declared to be normally distributed and comes from the same (homogeneous) data, then an N-gain test can be performed to measure the increase in students' science literacy in control class and experimental class. The N-gain results for science literacy in each dimension are shown in Table 9.

Table 9. N-Gain Score During Large Scale Testing

Class	Science Literacy Dimension	Ngain Dimension	Ngain
Experimental	Knowledge	0.70	0.58 (Moderate)
	Competence	0.57	
	Context	0.61	
Control	Knowledge	0.18	0.21 (Low)
	Competence	0.20	
	Context	0.23	

Table 9 shows an increase in science literacy among students in the experimental class categorized as moderate by 0.58, while the control class was only categorized as low by 0.21. Learning activities in the ethnoscience e-module are packaged with inquiry syntax that can train students' literacy and contain practical activities that encourage students to apply scientific methods that emphasize asking questions, developing hypotheses to answer questions, and testing hypotheses using investigation data (Masithah et al., 2022).

### ***Evaluation Stage***

Every stage of ADDIE is evaluated to obtain better development products. During the analysis stage, limitations were found in teaching media integrated with the surrounding environment, so teaching materials based on local wisdom were developed with the theme of Betawi tape uli, which is relevant to biotechnology and physical and chemical changes in the form of e-modules. In the design stage, the e-module was compiled with a storyboard and integrated with interactive features such as videos, hyperlinks, and evaluation questions at the end of each session to train students in developing science literacy.

The design stage produced a e-module draft, which was then validated by experts. The results of the validation by experts, with several improvements, were used to conduct a mid-scale test to test the product in real conditions. Based on the sig value of the one paired sample t-test and the Ngain test, there was a significant difference in students' science literacy before and after using the e-module, with a moderate increase. At the implementation stage, the e-module was proven to be effective in improving students' science literacy based on the independent t-test and N-gain, which was categorized as moderate.

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#### 4. Conclusion

Based on the research findings and discussions presented, the e-ethnoscience module is considered valid based on the assessments of lecturers and science teachers. Expert validation results show that the ethnoscience e-module is highly suitable for use in science learning in the classroom. The difference in N-gain scores between the experimental class that used the e-module and the control class that did not use the e-module proves that the e-module is effective in improving science literacy. The N-gain score in the experimental class was moderate, while the N-gain score in the control class was low. Therefore, it can be concluded that ethnoscience e-module is valid and effective in improving the science literacy of junior high school students.

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