



Development of a Problem-Based Learning Module Integrated with the Ethnochemistry of the Sasak Tribe to Improve Students' Scientific Literacy

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ABSTRACT

This study aims to develop a problem-based learning module integrated with the ethnochemistry of the Sasak tribe to improve students' scientific literacy that is feasible, practical, and effective. This type of research is development research, Research and Development (R&D), based on the development model of Nieveen, N., which includes the stages of preliminary research, prototyping, summative evaluation, and systematic reflection and documentation. The subjects of this study were students from two private senior high schools located in East Lombok. The large-scale trial used a pretest-posttest control group design. The results of the study showed that the average feasibility score for the problem-based learning module integrated with the ethnochemistry of the Sasak tribe was 78.5 in the feasible category, and the scientific literacy instrument obtained a score of 82.6 in the very feasible category. The use of the ethnochemistry learning module for the Sasak tribe received an average score of 80.3 from teachers and students, with very practical criteria. The ethnochemistry learning module for the Sasak tribe was effective in improving students' scientific literacy, with scores for X increasing from 51 to 84.52 and for Y increasing from 44 to 75.8, with average N gains of 0.68 and 0.57 in the medium category. These results indicate that the problem-based learning module, integrated with the ethnochemistry of the Sasak tribe and developed to improve students' scientific literacy, meets the criteria of feasibility, practicality, and effectiveness.

Keywords: development, PBL, ethnochemistry, scientific literacy

INTRODUCTION

Facing the twenty-first century, many challenges must be faced by teachers and students [1], including instilling scientific literacy in students so that students not only understand chemistry theoretically, but are also able to see the values and applications of chemistry in various contexts, because scientific literacy has become one of the main objectives of twenty-first-century chemistry learning [2]. Primadianningsih, C., [3] defines scientific literacy as students' understanding of scientific concepts and the application of chemical knowledge to natural phenomena in everyday life.

The importance of instilling scientific literacy in students has not been fully realized by teachers. In fact, according to the report [4] through the Programme for International Student Assessment (PISA) in 2022 [5] shows that the scientific literacy ranking of Indonesian students is 71st out of 81 countries, categorized as low. This is caused by the fact that teachers still make limited use of the sociocultural environment as a learning resource, even though local wisdom has the potential to be used as a chemistry learning resource that is closely related to everyday life [6]. The Programme for International Student Assessment (PISA) 2022 defines

scientific literacy as the ability to use scientific knowledge, identify questions, and draw conclusions based on evidence, to understand and make decisions regarding nature and the changes made to nature through human activities [4]

An important effort that must be carried out to address the challenges of the twenty-first century is to present an alternative learning resource in the form of a module that integrates problem-based learning with the ethnochemistry of the Sasak tribe. Problem-based learning, as a constructivist learning model, emphasizes that students solve problems independently and collaboratively [7]. When integrated with ethnochemistry, problem-based learning can facilitate the exploration of chemistry concepts through the local wisdom of the Sasak tribe. One local wisdom of the Sasak tribe that can be integrated into chemistry learning is the "*merarik*" tradition. This tradition has a very strong relevance to the theory of chemical bonding. The philosophy and basic principles of *merarik* are based on the concept of mutual need through the exchange between male and female parties, which is legalized through the marital bond (*merarik*). The concept of mutual need in the context of chemistry

learning, namely through the exchange of electron pairs to achieve stability, is the concept that underlies the formation of chemical bonds such as the concept of electron configuration, the concept of positive and negative ions, ionic bonds, polar covalent bonds, nonpolar covalent bonds, and the theory of chemical bond formation, so it can be concluded that the theory of chemical bonding is related to the local wisdom of the Sasak tribe.

One learning approach that combines chemical concepts with culture and local wisdom is ethnochemistry. Singh, I. S. [8] defines ethnochemistry as a cultural practice that describes chemical concepts associated with a cultural group and can be identified as chemical concepts or ideas found in any culture. By understanding culture and local wisdom scientifically, students can use them as a natural laboratory, directly allowing them to learn chemical concepts by connecting them to their surrounding environment; thus, it is expected to improve students' scientific literacy skills. Therefore, an ethnochemistry-based module is very important in learning, which is expected to provide students with the opportunity to experience knowledge as a process of character strengthening, as well as the opportunity to learn from the local wisdom of their surrounding environment [9].

The novelty of this study lies in the development of a problem-based learning module that is integrated with the ethnochemistry context of the Sasak tribe as a means to improve the scientific literacy of senior high school students regarding chemical bonding material, different from previous studies in which modules were only developed focusing on abstract concepts without being integrated with local wisdom and students' daily experiences, making chemistry material difficult to understand, and only applying either the PBL model or the ethnochemistry approach separately. This study combines both methods into a single, comprehensive, and relevant learning package, thereby producing a meaningful, culturally grounded learning experience that supports the achievement of twenty-first-century competencies.

Based on the description of the background, the researchers were interested in conducting a study to develop a problem-based learning module integrated

Table 1. Feasibility criteria for the ethnochemistry module of the Sasak tribe

Score obtained	Criteria
80-100	Very Feasible
66-79	Feasible
56-65	Fairly Feasible
40-55	Less Feasible
30-39	Not Feasible

Practical testing of the learning process was carried out using observation sheets for learning implementation, as well as teacher and student responses to the learning process, using the product developed. In the process of analyzing teacher and student responses to the learning tools and learning methods used, score determination was carried out using a Likert scale that had five levels, namely: not practical (score 1), less practical (score 2), fairly

with the ethnochemistry of the Sasak tribe that is feasible, effective, and practical for improving students' scientific literacy

RESEARCH METHODS

This type of research was development research (Research and Development / R&D). Development research was a research method that was used to produce a specific product and to test the effectiveness of that product [10], the development model used in this study was the development model by Nieveen, N., McKenney, S., and Van den Akker, J. [11], which included the stages of preliminary research, prototyping stage, summative evaluation, and systematic reflection and documentation [12].

This study focused on developing a problem-based learning module integrated with the ethnochemistry of the Sasak tribe to improve students' scientific literacy. In the large-scale trial, a practicality test was conducted using observation sheets, and an effectiveness test was conducted to assess students' scientific literacy.

The study population comprised all eleventh-grade students at two senior high schools in East Lombok. Schools X and Y served as the trial schools, with one class serving as the experimental class and the other as the control class. The trial sample was selected using the purposive sampling technique, in which the researcher directly selected the class to serve as the study's sample, based on the specific objectives of the research.

The product's feasibility was tested through expert validation and validity testing of the instrument for the learning module validation sheet, the syllabus, the teaching module or lesson plan, and the research instruments. This validation was analyzed qualitatively to inform revisions to the developed product. The expert response questionnaire data were analyzed by transforming the average score of all aspects with the criteria as shown in Table 1 [13].

The data analysis to determine the product's feasibility was conducted using the feasibility percentage formula.

$$\% \text{ feasibility} = \frac{\text{Score obtained}}{\text{Maximum score}} \times 100\%$$

practical (score 3), practical (score 4), and very practical (score 5). The data regarding the practicality level were analyzed using the following formula.

$$P = \frac{\sum x}{\sum x} \times 100\%$$

The practicality level was described by confirming the percentage of the scoring results achieved with the practicality criteria presented in Table 2 [14].

Table 2. Practicality criteria for the ethnochemistry module of the Sasak tribe

Score obtained	Criteria
80-100	Very Practical
66-79	Practical
56-65	Fairly Practical
40-55	Less Practical
30-39	Not Practical

The product's effectiveness was tested by assigning scores using the scientific literacy assessment rubric, which consisted of 10 essay questions. An N-Gain test was then conducted to assess the improvement in students' scientific literacy.

$$Gain\ index = \frac{Posttest\ score - Pretest\ score}{Maximum\ score - Pretest\ score}$$

The results of the N gain calculation were categorized according to the criteria in Table 3 [15].

Table 3. N gain assessment criteria

Skor	Criteria
$g \geq 7$	High
$0,3 \leq g < 0,7$	Medium
$G < 0,3$	Low

RESULT AND DISCUSSION

The product developed was a problem-based learning module integrated with the ethnochemistry of the Sasak tribe, a lesson plan, and a scientific literacy instrument. The following is an explanation of each development stage;

1. Preliminary Research Stage

The activity carried out in this stage was problem analysis, which was conducted to determine the fundamental problem in the development of the problem-based learning module integrated with the ethnochemistry of the Sasak tribe. At this stage, the researchers generally observed that the problems that emerged in the chemistry learning process in eleventh grade were that teachers did not use local wisdom, such as the traditions of the Sasak tribe, as learning materials or practices in chemistry. Yet this local context could serve as a real-world example that helps students understand chemical concepts in everyday life. Sudarmin supported these findings [16], who stated that integrating ethnosience, including ethnochemistry, could improve students' comprehension, motivation, and scientific literacy. Students had difficulty connecting with real phenomena or making decisions based on scientific evidence. These findings were consistent with the study by Fauziah and Wulandari [17], which showed that the low level of scientific literacy was due to the lack of problem-based learning experiences that required students to think scientifically and critically. In addition, students had the ability but were not fully facilitated, which contributed to their low scientific literacy.

The module that was used was still general and had not been adapted to the local context of the Sasak Tribe. Yet problem-based learning in an ethnochemistry context could be an effective way to improve students' scientific understanding.

The study conducted by Nugraheni et al. [18] also supported this. They found that developing a PBL-based module with ethnosience material significantly improved students' critical thinking skills and scientific literacy. The student needs analysis stage, namely the curriculum analysis, used

the Merdeka Curriculum to determine the basic competencies and competency achievement indicators. The most commonly used learning models were PBL and discovery learning, but their implementation was inappropriate. Therefore, students needed a learning module that explained basic chemistry concepts and integrated local wisdom or culture into the learning process in a scientific manner. Therefore, developing a Problem-Based Learning module that combines the ethnochemistry of the Sasak Tribe was a strategic solution. PBL provided students with opportunities to actively solve everyday problems, while the use of ethnochemistry offered a more meaningful learning experience because it was related to their own lives and traditions.

2. Prototyping Stage

The activities carried out in this stage were: first, the design of the module by collecting relevant images related to the learning material; creating the scientific literacy instrument and the expert validation instrument; and developing the module flowchart and storyboard for development needs. Second, the development of a problem-based learning module integrated with the ethnochemistry of the Sasak Tribe. The module's learning materials were presented in line with the characteristics of the learning content, which consisted of facts, concepts, principles, and procedures based on local wisdom.

Third, the next step that was carried out was the feasibility, practicality, and effectiveness testing of the learning tools that were developed, which consisted of the syllabus, the Teaching Module (lesson plan), the problem-based learning module integrated with the ethnochemistry of the Sasak Tribe, and the students' scientific literacy instrument, and these were evaluated by three expert validators or material experts in the field of chemistry education and language. The expert validation results are presented in Table 4.

Table 4. Product validation results

Learning Tools	Validator			Skor rata-rata	Learning Tools
	I	II	II		
Syllabus	75	77.7	66.6	73.1	Feasible
Teaching Module	76.9	71.1	73	73.6	Feasible
Scientific Literacy Instrument	81.2	87.5	79.1	82.6	Very Feasible
Ethnochemistry Module of the Sasak Tribe	80	79.5	76.1	78.5	Feasible

Based on Table 4 above, it showed that the average percentage of the syllabus feasibility results was 73.1% with the feasible criteria, the teaching module was 73.6% with the feasible criteria, the average feasibility of the scientific literacy instrument was 82.6% with the very feasible criteria, and the ethnochemistry learning module of the Sasak Tribe was 78.5% with the feasible criteria. This was in line with the research findings of Septyanigrum, K., and Lestari, N. A. [17], which stated that learning tools, including the syllabus, lesson plan, teaching materials, and instruments, were in the feasible category and could be used in the learning process. The study by Kaya, V. et al. [19] showed that the validation results of the module were in the feasible category, so that it could be used in learning; thus, it could be concluded that the problem-based learning

module integrated with the ethnochemistry of the Sasak Tribe and the scientific literacy instrument could be implemented in chemistry learning.

3. Summative Evaluation Stage

This stage comprised a limited trial and a large-scale implementation of the problem-based learning module integrated with the ethnochemistry of the Sasak Tribe for eleventh-grade students in Phase F at two private senior high schools in East Lombok.

The learning tools that had been declared feasible were then tested. This trial aimed to determine the practicality of the chemistry learning tools developed. The practicality of the learning tools was assessed based on the teachers' and students' responses. The results of the practicality test for learning implementation are presented in Table 5.

Table 5. Teacher and student response results

Respondent	Average (%)	Criteria
Learning implementation	78.0	Practical
Teacher	84.3	Very Practical
Student	78.5	Practical
Average	80.3	Very Practical

Table 5 showed that the average percentage of teacher and student responses was classified as very practical, with a score of 80.3 in the implementation of the problem-based learning module integrated with the ethnochemistry of the Sasak Tribe. This was consistent with the study by Gudesma, A., Ismet, and Kistiono [20], which reported that the ethnosience-based science module had a high level of practicality. This was also in line with the study by Syahpuri, C. E.,

et al [21], which stated that the ethnosience module was considered feasible and practical for contextual learning, that teachers found it easy to use, and that students responded positively to its connection to local culture.

In the large-scale trial, the practicality test used a student attitude questionnaire toward science, and the effectiveness test used a test of students' scientific literacy.

Table 6. Average results of students' scientific literacy

School	Average (%)		N-Gain	N-Gain Criteria
	Prettest	Posttest		
X	51	84.52	0.68	Medium
Y	44	75.8	0.57	Medium

Based on Table 6 above, the problem-based learning module integrated with the ethnochemistry of the Sasak Tribe was found to be effective in improving students' scientific literacy. This was evidenced by the increase observed before and after using the module, with an average N gain in the medium category. This was consistent with the findings of Dewi, C. A., Yahdi, and Sanova, A. [22], who stated that the use of an e-module in ethnochemistry could improve students' chemical literacy, especially in solving environmental problems.

The study by Gudesma, A., Ismet, and Kistiono [20] showed that there was an increase in students' scientific literacy skills, as seen from the N-gain analysis of the pretest and posttest, with a result of 0.68 in the medium category. Furthermore, the study conducted by Juwita, E., and Rosidin, U. [23] reported that the improvement in scientific literacy was effective, with a high category based on the N gain, and based on the effect size value of 98% with a large effect category.

Compared to conventional teaching modules currently implemented in schools, material based on

ethnochemistry and scientific literacy proved more effective at strengthening students' understanding and participation. This occurred because the chemical bonding material improved students' skills in communicating and collaborating in groups, and helped them connect scientific knowledge with real-life contexts. Thus, integrating the ethnochemistry of the Sasak Tribe into learning helped students understand chemical concepts more contextually and meaningfully by connecting them to local wisdom [24].

The study previously conducted by Martawijaya, M. A., and Hasyim, M. [25] focused on local wisdom or culture and was proven successful in improving students' scientific literacy skills. Learning with an ethnochemistry approach within a problem-based learning model provided students with opportunities to be directly and actively involved in scientific activities. This also provided students with real experiences of learning chemistry in the context of local wisdom. Hence, the concepts students understood were easier to remember, and they gained a better understanding of the material. The implementation of ethnochemistry in learning could be carried out by connecting chemical concepts related to the values of local wisdom and chemical practices in everyday life [26]; [27].

Both schools showed N-gain results in scientific literacy in the medium category, due to factors such as pretest scores, motivation, and the same learning model, in line with the study conducted by Alia, R. [28], it could be concluded that the ethnoscience approach could significantly improve chemical literacy skills in chemistry learning, so the N-gain value was classified as high.

CONCLUSION

Based on the results of the data analysis and discussion, it could be concluded that the problem-based learning module integrated with the ethnochemistry of the Sasak Tribe to improve students' scientific literacy was feasible to use. The limited trial received responses from teachers and students in the very practical category, with a score of 80.3. The problem-based learning module integrated with the ethnochemistry of the Sasak Tribe improved the scientific literacy of students X and Y, with average N-gain scores of 0.67 and 0.57, respectively, in the medium category.

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