The Development of Ethnoscience Based Acid-Base Modules to Improve Students' Scientific Literacy Ability

by Fpmipa Undikma

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The purpose of this study is to development of ethnoscience based acid-base modules to improve student's scientific literacy ability. This study was development research with the ADDIE design model with limited to the evaluation stage. The draft module was validated by two material experts and one media expert using a validated questionnaire. The module effectiveness test uses a pre-experimental model with one group pretest-posttest only research design for the number of research subjects as many as 30 students. Module effectiveness is analyzed from graduation, n-gain scores, and t-test results of the pretest-posttest. The results of content and design validations are 80% and 87% with valid criteria without revision, n-gain score of 0.4 with medium category and t-test showed that there were significant differences between pre-test and post-test. Thus it can be concluded that the ethnoscience based acid-base module can effectively improve students' scientific literacy ability in basic chemistry learning.

Keywords: *Acid-Base Modules, Ethnoscience, Scientific Literacy Ability*

Introduction

In the 21st century, the development of science, technology, and information takes place very quickly and is full of competition. To anticipate and win this competition, Indonesians must prepare themselves by growing and developing many competencies (Suardana et al., 2018). Thus, it brings the impact of a tight race in all areas of life. National education graduates must have competitive and comparative advantages according to national quality standards to win job opportunities in this global era. In line with the rapid development of IT and dynamic social change, it is necessary to prepare Indonesian science teachers who can compete freely and have the toughness in thinking and act scientifically to solve problems encountered (Setiawan et al., 2017). Science education plays a useful role in the world around it. To understand the importance of science better, the scientific environment needs to be known through systematic knowledge. The creation of science literacy is one of the most critical goals of scientific education (Drago & Mih 2015). The ability to understand and involve meaningful science-based information available in daily life is scientific literacy (Fives et al., 2014).

The results of a PISA study showed that Indonesian students' average scientific literacy score was well below the international average, suggesting that Indonesian student science literacy is still very poor. Indonesia has always obtained a score below the average rating. Based on data from PISA 2012, Indonesia ranked 64 out of 65 participating with the average acquisition of the scientific literacy component about 382 (OECD, 2014). The findings of this study (Sumarni, 2018) showed that the daily life of Indonesians does not reflect on what so-called being "literate" of chemistry. Many people still show incapability of applying knowledge of chemistry to their life. The research conducted by Sujana et al. (2014); Sulistiawati (2015); Sumarni et al. (2017); Hastuti (2019); Dewi (2019); and Dewi & Mashami (2019) find that most students have difficulty in applying chemistry education in the real world. The finding supports Celik (2014) and Bacanak &Gőkdere (2009) that 56% of prospective chemistry teacher is unable to deliver proper and correct information regarding nominal and functional literacy of chemistry. The findings of this study (Kemendikbud, 2013) showed that Low levels of scientific literacy are attributed to a number of the PISA test materials that were not included in the Indonesian science curriculum, but also to the unavailability of ethnoscience modules that fulfill the curriculum requirements and graduate competence criteria. Not all changes in the Indonesian curriculum were followed by ethnoscience modules suitable for the new requirements.

A major measure of the standard of education is the large number of students who lack basic skills in science. According to (OECD,2013), students at Level 1 are restricted in scientific information that they only apply in such familiar situations; they are also able to offer scientific theories simply and directly only on the basis of facts. High-quality education in science is not only essential in preparing students to pursue their career in science, but also to help prepare a community of people who are academics and can 'meet current global challenges' (Wieman, 2007). Scientific education in this regard helps to realize the potential of students and leads to the growth of the human capital of a nation (Reddy, 2006).

Ethnoscience modules have a huge influence on campus science education. One of the purposes of college science education is to prepare individuals for lifelong learning in the real world; therefore it is important to research the degree to which ethnoscience modules are structured to achieve this purpose. Modules are an important resource in the teaching and learning process; hence efforts should be made to ensure the collection and recommendation of high-quality ethnic modules for the campus. A high quality module is considered to be the key means of promoting the education and development of a country. Science teachers rely heavily on existing modules. Ethnoscience modules allow teachers to include a subject or lesson's organizational framework. Modules often provide different tools for gathering additional knowledge and for developing more accurate concepts. They also help train students and develop the science they need. The modules also benefit from helping to reduce the problems associated with the lack of knowledge on the context. Ethnoscience modules are important in the early phases of teaching and learning for generating scientific theories and clarifying scientific concepts. They are the key source used by science educators worldwide to direct them in their teaching on curriculum material and skills. The standard of these modules will have a significant influence on the quality of the teacher training as they use modules as their curriculum guide and as tools for planning their curriculum (Lemmer et al., 2008; Newton & Newton, 2006; Ogan-Bekiroglu, 2007; Reys & Reys, 2006; and Brandt, 2005; Holbrook & Rannikmae, 2009; Rusilowati et al., 2016).

One way of improving student scientific literacy is to build ethnoscience modules. Dewi et al.(2019) said that scientific literacy should be built by focused on preparing upcoming generations of scientific literacy with curriculum content that discusses culture and everyday life to make it more contextual. Sinaga et al.(2017) found that the design of better science textbooks would enhance the scientific literacy skills of secondary school students. Alim et al.(2019) said that guided research learning based on ethnoscience has important impacts on the mastery of scientific literacy and the character of the student. Fitria & Wisudawati(2018) reported that the book on the enrichment of ethnosciences should be a source of students' scientific knowledge. Atmojo et al.(2018) have shown that integrated ethnoscience science learning can improve scientific literacy and scientific character. On the basis of these claims, ethnoscience-based acid-based modules must be built to enhance student scientific literacy. Through the creation of ethnoscience focused acid-based modules, students are expected more reliant than technology, progress and the development of science on scientific literacy in terms of how they view the climate, health, the economy and the problems of modern society.

The purpose of this study is to development of ethnoscience based acid-base modules to improve student’s scientific literacy ability. This ethnoscience based acid-base module was developed on the grounds that (1) the need for a learning resource in the form of ethnoscience based acid-base modules that raised the local culture as a form of a love of the nation's culture and then studied from the side of science as a source of students' scientific literacy, so can improve students scientific literacy ability, (2) the unavailability of the chemical book based on ethnoscience common in the community, so with the ethnoscience based acid-base modules is expected students can know the application of chemistry in daily life primarily in the culture of a society in Indonesia.

Research Method

This study was development research with the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) design model. The development model used is limited to the fifth stage, i.e., the evaluation, which includes the following stages:

1. The analysis study stage includes research and data collection (research and information collecting), consisting of: need assessment and curriculum which is useful to know the product needed and will be developed, literature study related to product development especially in the form of a book, and ethnoscience concept which will become the characteristics of the book to be developed, as well as the analysis of materials related to local cultures (Sasak) that can be translated scientifically science.
2. The design study stage includes planning, gathering references for ethnoscience-based chemistry in culture.
3. The development study stage includes initial development of product draft (develop a preliminary form of product) includes the preparation of systematics and components contained in the ethnoscience based acid-base modules, preparation of the contents of the ethnoscience based acid-base modules and determine the design lay-out or book cover, consult the initial product results with supervisors, product validation, as well as product revisions. Preliminary field test (preliminary field test), the draft module was validated by two material experts and one media expert using a validation questionnaire and responded by ten students from the chemistry education study program FSTT UNDIKMA Mataram. Revision of the trial results (first product revision). At this stage, the product improvement is based on an assessment by reviewer and response from the chemistry education study program students.
4. The implementation study stage includes the module effectiveness test to measure students' scientific literacy ability.

Table 1. Criteria for Product Feasibility and Revision

Achievement Level (%)	Qualification	Information
81-100	Very good	No need to revision / valid
61-80	Good	No need to revision / valid
41-60	Enough	Revised / invalid
21-40	Less	Revised / invalid
0-20	Very less	Revised / invalid

(Fives et al., 2014)

The module effectiveness test uses a pre-experimental model with one group pretest-posttest only research design for the number of research subjects as many as 30 students. The instrument used was a reasonable multiple-choice question used to measure students' scientific literacy ability. The increase in students' scientific literacy in this study was determined based on the average score gain normalized by Hake's criteria and t-test results of the pretest-posttest.

$$\%g = \frac{\%Sf - \%Si}{100 - \%Si} \times 100\%$$

With:

g = normalized gain
Sf = posttest score
Si = pretest score

The calculation results obtained <g> value are then interpreted into three categories Hake (Ardianto & Rubini, 2016) namely:

Table 2. Gain value classification

Average Gain	Criteria
$0,00 < g \leq 0,30$	Low
$0,30 < g \leq 0,70$	Medium
$0,70 < g \leq 1,00$	High

The Result and Discussion

To obtain a learning module that meets the criteria of being valid and can measure the ability of students' scientific literacy, the researcher follows the development procedure using the ADDIE model are analysis, design, development, implementation, and limited to the evaluation stage.

a. Analysis Stage

During the analysis phase, activities include analysis of student needs and problems, curriculum analysis, learning resources analysis, and evaluation.

1. Analysis of Student Needs and Problems

Researchers examine the basic problems faced by students in learning, so they need to develop teaching materials in the form of modules. The results of researchers' research on problems that arise in chemistry learning include: a) The many, varied and integrated material causes students to be less interested in learning chemistry especially in acid-base material, b) The lecture still uses conventional methods and the material presented by the lecturer is one-way, so students are unable to understand the material well, c) The use of teaching materials such as textbooks owned by lecturers is still in the form of improvised textbooks, and not many students have a handbook such as worksheets or other relevant chemistry books causing less student interest and less satisfying in undergoing the learning process so that students' scientific literacy abilities are low. The researches of Sumarni et al. (2017) and Bacanak & Gőkdere (2009) show that many students of chemistry education are incapable of showing the application of chemical concepts as well as relating that to the surrounding phenomena. This condition shows that students' learning outcomes in their senior high or university are not enough to make the literate in chemistry. This literacy reflects the readiness of citizens to encounter global challenges (ArcherBradshaw, 2017; Holbrook & Rannikmae, 2009).

2. Curriculum Analysis

Curriculum analysis is carried out to map the core competencies and basic competencies relating to acid-base material in the curriculum as a basis for making indicators and learning objectives of modules. The findings of this study (Dewi et al., 2019) stated that focusing on the preparation of future generations of scientific literacy through the cultural-based curriculum to produce more contextual learning, particularly learning resources used in the classroom learning process to elevate local culture related to basic chemistry learning.

3. Learning Resources Analysis and Evaluation

Analysis of learning resources is done to determine the situation and conditions of chemistry learning in the UNDIKMA Mataram of chemistry education study program. Analysis of learning resources is like the textbooks that are used by lecturers only contain material and questions that must be resolved by students, do not train students in solving problems encountered, and are less contextual or lack examples that can be applied in daily life. Based on the results of the analysis found that the appropriate teaching material is by designing modules that are varied with ethnoscience models on acid-base material to improve students' scientific literacy abilities. The findings of these studies (Sumarni, 2016; Fitria & Wisudawati, 2018; Atmojo et al., 2018) showed that ethnoscience-based chemical books could increase students' scientific literacy ability.

b. Design Stage

During the design phase, activities include: Determine and design appropriate learning models, designing learning modules.

1. Determine and design appropriate learning models

In the module developed, teaching and learning activities use learning models, namely ethnoscience, which aims to improve students' scientific literacy ability. The steps of the learning process modify the Chemie im Kontext (Nentwig et al., 2007) based on the following sequences: 1) Contact phase: In the learning process, the lecturer invites students to discuss the application of the material in everyday life; 2) Curiosity phase: The teacher involves social problems to the decision-making component for specific problems related to chemistry and engages students in the problem-solving phase (Holbrook et al., 2008); 3) Elaboration phase: there is an exploration, experiment, and chemical concept formation to students. These activities are in detail, explained as the exploration of the local context, the experiment to the proximate element, and the reconstruction to social understanding during field observation. From these events, it is expected that students will understand the importance of chemistry in their community; 4) Decision-making phase: the students made a decision under the guidance of the lecturer as their facilitator. During the field observation, students can find phenomena that are strongly related to chemistry in acid-base. The lecturer supports them to think about "why," "how," etc. During the observation, students are also training themselves to explore their knowledge. The students can come with the knowledge which they previously have and relate their understanding to the concepts in chemistry; 5) Nexus phase: the students make a decision based on the materials and apply that to another context; 6) Evaluation phase: there is an evaluation to the learning process to value students' success, including to the aspects of content, context, and competence.

2. Designing learning modules

This stage carried out the specifications of the results of the development that has been produced, namely a module with ethnoscience learning models on acid-base material to improve students' scientific literacy ability. From this stage, a module design review is obtained as follows: (1) module cover; (2) foreword; (3) table of contents; (4) learning objectives; (5) introduction consists of; background, module description, prerequisites, core competencies, basic competencies, indicators, module usage instructions, concept maps; (6) learning activities include activity 1 (contact), activity 2 (curiosity), activity 3 (elaboration), activity 4 (decision-making phase), activity 5 (nexus), activity 6 (evaluation); (8) concluding consists of feedback and follow-up, expectations, glossary, answer key, bibliography and about the author.

c. Development Stage

At the development stage, teaching materials in the form of modules that have been prepared are validated by three experts and trial. The following is the product validation data presented on the results of the response/feasibility of teaching materials developed.

Table 3. The Validation Value of Expert Content/Material

Module Learning Aspects	Earnings score (%)
Cover and Content	80
Average score	80%
Qualification/Information	Good/Valid

Based on table 3 from the content/material expert field, there is an assessment of the cover and content aspects of the material with an acquisition score of 80% with good and valid qualifications used as teaching material in basic chemistry learning.

Table 4. The Validation Value of Design Experts

Module Learning Aspects	Earnings score (%)
Cover Feasibility	90
Appearance and Presentation	84
Average score	87%
Qualification/Information	Very Good/Valid

Based on table 4 from the results of the assessment of the feasibility of the cover, the appearance and presentation aspects of the design experts obtained an average score of 87% with very good and valid qualifications used in basic chemistry learning.

Table 5. The Validation Value of Practitioner Experts

Module Learning Aspects	Earnings score (%)
Cover and Content	91
Average score	91%

Qualification/Information	Very Good/Valid

Based on Table 5 of the validation of practitioners, there is an assessment of the cover and content aspects with a score of 91% with excellent qualifications and valid for use in basic chemistry learning.

Table 6. The Trial Value of Students

Indicator	Earnings score (%)	Category
Like learning to use the ethnoscience module	81	Positive
Easily understand the material on the ethnoscience module	86	Positive
Motivated to learn to use the ethnoscience module	84	Positive
Motivated to solve the problems contained in the ethnoscience module	91	Positive
Self-study using ethnoscience modules	85	Positive
Average	85%	Positive

Table 6 shows that overall, students responded positively to the use of ethnoscience-based acid-base modules in basic chemistry learning.

Based on the results of research that has been done, the results of expert validators in the field of content/material with an average score of 80 with good qualifications and criteria do not need revision/valid. The qualitative data or responses or suggestions for improvement provided by the validator are good enough. From the results of the research that has been done, the results of the expert validator in the field of product design with an average score of 87 with very good qualifications and criteria do not need revision/valid. The qualitative data or suggestions for improvement provided by the validator are the modules that can be used or applied in a learning activity, but there is a revision made in advance about the cover that needs to be repaired and completed with the author's biodata. The acid-base module cover suggestions and corrective responses on initially mentions acid-base material, salt hydrolysis, and buffer solutions. However, to make it better and according to it, it would be nice to remove the title by writing salt hydrolysis, and the buffer solution is only used acid-base because it represents a buffer solution and salt hydrolysis because it is included in the acid-base material.

Based on the results of the research that has been done, the results of the practitioner validator with an average score of 91with very good qualifications and the criteria do not need to be revised /valid. As for the qualitative data or responses or suggestions for improvement provided by the validator that is, it should cover the full cover to make it more interesting, the writing should be improved like a general chemistry book and use a font type in general, and it should be filled in every sheet of paper to save books and chemistry books not too thick so that there is a lot of interest in reading, especially with a small amount of chemical interested, add chemical formulas. The results of trials that have been conducted on students with an average score are 85 with a positive student response category to the ethnographic-based acid-base module. The findings of these studies (Rusilowati et al., 2016; Sudarmin et al., 2017; Setiawan et al., 2017; Dewi et al, 2019; Sudarmin et al, 2019) showed that the ethnoscience pedagogic in chemistry learning could develop student scientific literacy in terms of content, competence, context, and attitude.

d. Implementation Stage

To find out the increase in students' scientific literacy abilities were analyzed using t-test and n-gain, as seen from the table, is presented as follows.

Table 7. T-test Value of Student Scientific Literacy

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Scientific Literacy	Equal variances assumed	.971	.328	3.170	62	.002	4.34375	1.37040	1.60436	7.08314
	Equal variances not assumed			3.170	61.886	.002	4.34375	1.37040	1.60426	7.08324

Based on table 6, the Sig. (0.002) <0.05, which indicates that there is a significant difference between students' scientific literacy before and after using ethnoscience-based acid-base modules.

Table 8. Value of Scientific Literacy Aspect

Scientific Literacy Aspect	% Pre-test	% Postest	% N-Gain
Content	55	69	31
Process	65	79	40
Attitude	54	77	50
Average	58	75	40

Based on table 8, the N-Gain average scientific literacy aspects of content, process, and attitude is 40%. This shows that the scientific literacy ability of students is included in the medium category.

Based on the results t-test, a significant difference has been demonstrated between students' scientific literacy ability before and after using ethnoscience-based acid-base modules, while N-Gain average about 40% from scientific literacy aspects (content, process, and attitude) showed that students scientific literacy ability is increased. Research has been done by Sumarni (2018) It showed that applying ethnoscience-based learning in chemical science could boost literacy in chemistry for students. According to Dewi, et al. (2019) that the ethnoscience in chemistry learning can develop scientific literacy. Fitria & Wisudawati (2018) that the development of ethnoscience-based chemical enrichment books deserves to be a source of science literacy by students. The results of the study by Atmojo et al. (2018) it demonstrated that integrated science learning can boost scientific literacy for students with a benefit of0.81, which is included into the high category. Alim et al. (2019) showed that directed learning from ethnoscience has an important impact on the mastery of science literacy and on the character of the student. Melyasari et al. (2018) indicate that the student's scientific attitude could increase as well as learning activities get a positive response. Setiawan et al. (2017) The local science module developed was shown to be suitable for improving student science literacy theoretically and empirically. The findings of this study (Sumarni, 2018; Sumarni & Kadarwati, 2020; Fasasi, 2017; Parmin & Fibriana, 2019; Yuliana et al., 2018) showed that Implementing ethnoscience-based chemistry learning will increase the literacy of students in chemistry.

Conclusion

This study concluded that ethnoscience-based acid-base modules could be considered for use in basic chemistry learning so students are more active in independent learning and can construct concepts and apply chemical concepts in daily life. The implementation of an ethnoscience based acid-base module can improve students' scientific literacy ability in the learning and teaching process. The percentage is given at the pre-test, and post-test recapitulation report is evident for this conclusion. The pre-test score was 55% for content, 65% process, and 54% for attitude. Meanwhile, during the post-test, the scientific literacy ability increased for each indicator. Students' ability to content increased to 69%, their process increased to 79%, and their ability of attitude increased to 77%. This research suggests that the production of acid base modules based on ethnosciences is a good way to enhance scientific know-how for the students. This learning model should be implemented in various fields of education. Research with the same topic should be conducted in the future within different subject matters and in different contexts.

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