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Development of Syntax for Learning Chemistry Based On Etno-STEM to Build Scientific Literacy Skills and Critical Thinking Skills

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ABSTRACT: Local culture in learning canimprovestudents' scientificliteracy and criticalthinkingskills. The purpose of thisresearchis to develop a local culture-basedchemistrylearningsyntaxthatcan train students' scientificliteracy and criticalthinkingskills. This researchwasconductedusingresearch and developmentmethods. The development model in thisstudyincludes five procedures, namelypreliminaryresearch, productdevelopment, expert validation, testing, and implementation. The final productis an ethno-STEM-basedlearningsyntax, namely, HENIE.The results of the development of the HENIE syntax show that (1) the validation of the syntax product is in the Good and Very Good categories. The validator also gave a positive response to this research, (2) the percentage of lesson plan assessment of 90.90% was in the Good category, (3) the percentage of learning implementation assessment of 95.80% was in the very good category, (4) student literacy ability assessment is in the good category, and (5) the percentage of students' critical thinking skills reaching 85.83% is in the Good category.

Keywords –*syntax, ethno-STEM, science literacy skills, critical thinking skills*

I. INTRODUCTION

Science education has great potential in preparing quality human resources. Science education has the potential to produce students who are proficient in their fields. Science education can also foster the ability to think logically, think creatively, solve problems, be critical, master technology, be scientifically literate, and be adaptive to changes and developments of the times. Therefore, science education in Indonesia requires an educational curriculum that can bring success to the world of education in the future, one of which is preparing quality human resources in the era of globalization.

In carrying out their obligations as educators, according to Sudarmin[1],wise teachers must be able to insert the local cultural values of a local area in the process of learning science or non-science. Local culture in learning can improve students' scientific literacy and critical thinking skills. Students learn more effectively if they use the environment or equipment around them, thus stimulating students' curiosity, making observations, asking questions[2].

Local wisdom has a close relationship with ethnoscience in the community. Ethnoscience is a system of knowledge and cognition (ideas/thoughts) typical for a particular culture. Education based on local wisdom (ethnoscience) is education that utilizes local and global advantages in economic aspects, arts and culture, human resources, language, information and communication technology, ecology and others into the school curriculum. This is beneficial for the development of student competencies that can be utilized for global competition [1].Ethnoscience as national identity is something that needs to be considered in curriculum development in Indonesia [3]. The ethnoscience approach can be integrated with other learning models, one of which is the STEM learning model.

STEM can be interpreted as a term used to collectively refer to teaching and approaches across disciplines, namely science, technology, engineering, and mathematics. STEM can develop if it is associated with the environment, so that learning is realized that presents the real world experienced by students in everyday life (Subramaniam et al., 2012). This means that through the STEM approach students do not just memorize concepts, but rather how students understand and understand science concepts and their relationships in everyday life. Students are able to develop their competencies to be applied to various situations and problems they face in everyday life.

The application of the STEM learning model in chemistry is an approach that combines technology content to be integrated into chemistry, engineering, and mathematics subjects. This approach encourages students to ask questions and explore the environment through investigations and solving problems related to real-world situations, so that the purpose of STEM education is to produce students who, when they will enter the community, are able to develop the competencies they already possess to apply it to various situations and the problems they face in everyday life can be realized [4].

STEM integrated with ethnoscience will make learning meaningful and make it easier for students to transform science in society with scientific science and vice versa. This is in accordance with research conducted by Sudarmin which focuses on culture as a set of principles for creating dramas, for writing scripts, and of course, for recruiting players and audiences. The results of ethnoscience research, seem to be theoretical, although not a few of them are then of great practical benefit. Especially in relation to efforts to incorporate elements of new technology and knowledge into a society with a view to improving technology, social, cultural and economic activities of the community [1].

Ethno-STEM integration can improve students' scientific literacy skills. Scientific literacy can be defined as scientific knowledge and skills to be able to identify questions, acquire new knowledge, explain scientific phenomena, and draw conclusions based on facts, understand the characteristics of science, awareness of how science and technology shape the natural, intellectual and cultural environment, and willingness to be involved. and care about science-related issues [5]. In addition, ethno-STEM integration is also known to improve students' critical thinking skills.Critical thinking can be defined as one of the components in the higher-order thinking process, using the basis of analyzing arguments and generating insight into each meaning and interpretation, to develop cohesive and logical reasoning patterns[6].According to Black and Robert Ennis [7], critical thinking is the ability to use logic. Logic is a way of thinking to gain knowledge accompanied by an effective study of its truth based on certain patterns of reasoning.

The application of the ethno-STEM learning model is suitable to be carried out in Papua, one of the regions in Indonesia, which is rich in culture. This is because there is still a lack of internalization of cultural values in the chemistry learning process by teachers. However, to be able to apply the ethno-STEM learning model that is able to improve students' scientific literacy and critical thinking skills, it is necessary to develop an adequate learning syntax. The purpose of this research is to develop an ethnoe-STEM-based chemistry learning syntax to train students' scientific literacy and critical thinking skills.

II. LITERATURE REVIEW

2.1. Ethnoscience

Ethnoscience consists of two words, namely ethnos which comes from Greek which means 'nation' and the word scientia comes from Latin which means 'knowledge'. Thus, ethnoscience means knowledge possessed by a particular nation or ethnic group or social group as a form of local wisdom. Ethnoscience can be defined as knowledge possessed by a society or ethnic group which is obtained by using methods and following certain procedures[8]. The emphasis of this field of study in ethnoscience is on systems or knowledge devices that are unique to a society or a culture. Ethnoscience studies as a source of learning, for example the prey system system in the Javanese view, the Subak irrigation system according to the Balinese view, and how to make a Pinisi boat according to the Bugis, all of which contain scientific scientific concepts that have not been formalized[9].

Sudarmin said that there are three areas of study for ethnoscience research. The three fields of study are 1) ethnoscience which emphasizes the culture of the social situation at hand. This research study shows the symptoms of the material that is considered important for the community and how to organize these phenomena with the knowledge they have. 2) ethnoscience which emphasizes research in revealing the culture that exists in society in the form of values and norms that are prohibited or allowed as well as technological development. 3) ethnoscience which emphasizes culture as an event that can bring people together and influences daily behavior. The third research study is the study that is most often used as material for research studies in the scientific community [8].

Learning with ethnoscience is based on the recognition of community culture as a fundamental (fundamental and important) part of education as an expression and communication of an idea and the development of science. [10]. The local wisdom/ethnoscience-based science learning model is carried out by reconstructing the original science. Reconstruction can be intended as a rearrangement or translation of original science into western science concepts/scientific science [11].

2.2. STEM

STEM adalahakronimdari Science Technology Engineering Matemathic. Moore dk STEM is an acronym for Science Technology Engineering Mathematics. Moore et al.[12]stated that STEM is an approach and effort in combining several or four STEM subjects into one lesson based on the relationship between subjects and real-world problems. Kelley & Knowles [13]defines STEM as an approach to teaching two or more

STEM subjects related to practice in an authentic way so as to increase students' interest in learning. Sanders [14]explained that STEM is an approach that explores two or more STEM subjects and one or more subjects in school.

In the context of learning, STEM has 3 aspects, namely STEM as a field of learning studies, STEM as a lesson package and STEM as an R&D approach [15]. In its application, three kinds of STEM approaches are practiced in various places. The difference between the three STEM approaches lies in the level of STEM content used in learning. These approaches include the Silo STEM approach, the Embedded STEM approach, and the integrated STEM approach. This research focuses more on the integrated STEM approach. The integrated STEM approach is different from other STEM approaches. In this approach, subjects are not taught separately but are integrated with each other. The integration of STEM subjects requires students to connect different STEM subjects. The integration of these subjects begins with the identification of real problems that occur in the environment of students by using high-level thinking and problem solving skills so that conclusions can be drawn as an effort to solve these problems [12].

2.3. Science Literacy

Scientific literacy can be defined as scientific knowledge and skills to be able to identify questions, acquire new knowledge, explain scientific phenomena, and draw conclusions based on facts, understand the characteristics of science, awareness of how science and technology shape the natural, intellectual and cultural environment, and willingness to be involved. and care about science-related issues [5]. Literacy ability is a fundamental thing that must be possessed by students in facing the global era to be able to meet the needs of life in various situations. Scientific literacy is the ability to understand science, communicate science, and apply scientific skills to solve problems.

To improve scientific literacy skills, besides requiring student motivation, teachers also need to consider learning strategies that are in accordance with the conditions and potential of students in which the learning process focuses on providing direct experience and the application of the nature of science [16]. From a pedagogical perspective, literacy is not only a subject entity, but is an indicator of the success of curriculum implementation. The pedagogical process that takes place through the teaching and learning process in the classroom is a process of functional interaction between teachers and students as well as between students. In the interaction process, there are two phenomena of constructing knowledge and internalizing the values of social life. Both are processes of developing literacy competencies [5].

2.4. Critical thinking

Critical thinking ability is an ability to identify and determine a problem, which includes determining the essence, looking for similarities and differences, digging up relevant data, considering and assessing which includes distinguishing between facts and opinions, finding assumptions, separating prejudice and social influences, weighing consistency in thinking, and drawing conclusions that can be accounted for according to relevant data, and predicting the consequences that will arise[17]. According to Ennis and Norris, there are 4 steps that can develop critical thinking skills in a person which include, giving simple explanations, building basic skills, making conclusions, setting strategies and tactics[18].

AriefAchmad stated that there are 12 indicators of critical thinking ability which are grouped into 5 aspects of critical thinking ability, namely:

1) Provide a simple explanation (including: focusing questions, analyzing questions, asking and answering questions about an explanation),
2) Building basic skills (including: considering whether the source is reliable or not, observing and considering a report on the results of observations),
3) Summarizing (including: deducing and considering the results of deductions, inducing and considering the results of inductions, making and determining the value of considerations),
4) Provide further explanation (including: defining terms and definition considerations in three dimensions, identifying assumptions),
5) Set strategies and tactics (including: determining actions, interacting with others)[19].

III. METHOD

3.1. Research Types

This research was conducted using research and development methods or development research. Research and development (R&D) is a type of research oriented to product development. According to Sugiyono[20]research and development methods or in English Research and Development is a method to produce certain products, and test the effectiveness of these products. This study also uses a research method that refers to a modified development procedure from Asyhar[21], which contains the main steps of development research that aims to produce a product. The research was conducted at the Department of Civil Engineering, Musamus University in the Basic Chemistry course.

3.2. Research Procedure

The development model in this study includes five procedures, namely preliminary research, product development, expert validation, testing, and implementation. The stages of developing this product can be seen in Figure 1[21].

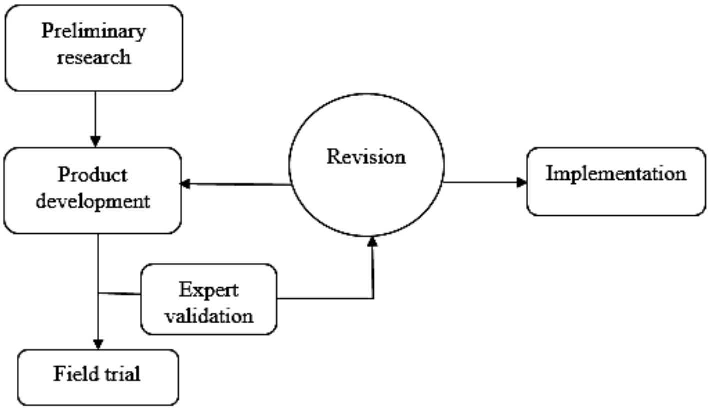

Figure 1. The Development Model

Preliminary research was conducted to identify learning needs (products), characteristics of educators and students, analysis of learning, and analysis of topic needs. At the product development stage, the process of developing the syntax of an ethno-STEM-based chemistry learning model is carried out to train scientific literacy and critical thinking skills. The result of this development is called draft I. After draft I has been compiled, expert validation is then carried out. Draft I received suggestions for improvement from experts, after being improved, the results of the improvements are called draft II. The results of the second draft were then tested on the lecturers of the Basic Chemistry course to find out its benefits. After that it is implemented to students to know its effectiveness.

3.3. Research Instruments

The research instruments used were material expert validation sheets, media expert validation sheets, lecturer response sheets on syntax implementation, scientific literacy skills sheets, and critical thinking skills sheets.The scientific literacy instrument used was adopted from the Take the Test Sample Question from OECD'S PISA Assessment totaling 20 scientific literacy questions consisting of 6 questions for the science content aspect, 9 questions for the scientific process aspect, and 5 questions for the science context aspect.The critical thinking instrument uses a critical thinking ability observation sheet based on predetermined criteria. The format used uses 4 categories namely very good, good, less, and very less.

3.4. Data Analysis Techniques

Expert validation assigns a score to each indicator in a score range of 1 to 5. The results of the average score are then interpreted according to table 1[22].

Table 1. Validation Criteria

Score Scale	Description
$4,2 < X$	Very good
$3,4 < X \leq 4,2$	Good
$2,6 < X \leq 3,4$	Enough
$1,8 < X \leq 2,6$	Less
$X \leq 1,8$	Very less

The implementation of the syntax developed from the results of the observation sheet that has been filled in by the observer. Each indicator in the learning phase that is implemented is given a score of 1, and if it does not appear, it is given a score of 0. The data obtained from the observation sheet is processed from the number of scores from each observer and the results are expressed in percentage form. The percentage of syntax execution is calculated using the following formula:

$$\text{Percentage of syntax execution} = \frac{number\ \ of\ activities\ \ carried\ \ out}{total\ \ number\ \ of\ activiti\ es} \text{ x } 100\%$$

The scientific literacy score is calculated using the percentage technique per each literacy aspect, then the results obtained are interpreted in table 9 [23].

Table 2. Interpretation of Literacy Skill Score Criteria

Criteria Interval	Criteria
86 % ≤ N < 100%	Very good
72 % ≤ N < 85%	Good
58 % ≤ N < 71%	Enough
43 % ≤ N < 57%	Less
N ≤ 43 %	Very less

Literacy skill percentage = $\frac{average\ \ score}{maximum\ \ score}x100\%$
which the maximum score is 20.

Critical thinking skill is calculated by the following percentage formula:
Critical thinking skill percentage= $\frac{average\ \ score}{maximum\ \ score}x100\%$

which the maximum score is 120.

IV. RESULTS AND DISCUSSION

4.1. Preliminary Research

This study aims to develop an ethno-STEM-based chemistry learning syntax to improve literacy skills and critical thinking skills. This research was conducted from October to December 2021 at the Department of Civil Engineering, Musamus University. The number of samples in this study were 30 students. Based on the results of interviews with students, was obtained that learning chemistry in class is still theoretical. This causes students difficulty in understanding learning. Students need innovative and creative learning to encourage their motivation and interest in learning. Furthermore, based on the results of interviews with subject lecturers, it is known that lecturers need facilities in presenting learning that is closer to the student environment. In addition, the lecturer stated that students have more dominant characteristics in the motor aspect and have great curiosity, but need more encouragement to be able to generate student interest in studying chemistry. To answer this problem, analysis of identification of learning needs, characteristics of lecturers and students, analysis of learning, and analysis of topic needswas carried out.

Based on the results of observations, interviews and literature studies, it is known that chemistry learning in the sample class is less oriented to the everyday environment of students. So that students find it difficult to translate the concepts conveyed by the lecturer. There have been efforts from lecturers to vary learning through games, group discussions, and project-based learning. This is enough to attract students' interest in learning chemistry. However, this is still not able to grow literacy skills and students' critical thinking skills in learning chemistry. It takes a simple learning syntax, oriented to the environment around students, easy to apply by lecturers, and able to improve literacy skills and students' critical thinking skills.

Based on the results of observations and interviews with lecturers in chemistry courses, it was found that lecturers needed guidance in carrying out classroom learning. The guide in question is a guide that is easy to learn and apply in class, does not require a long time, and can be applied to all study materials being taught. It can be concluded that the lecturer in chemistry course has a systematic character and has a clear achievement target. Judging from the efforts of learning variations that have been carried out, it can also be concluded that lecturers are dynamic and creative. Observations and interviews were conducted with students. Observations were carried out thoroughly, while interviews were only conducted on 5 students. The results of observations and interviews showed that students' interest in learning a new concept was determined by the way the lecturer delivered it and the media used in learning. The closer the concept of learning to everyday life, students become more interested in listening and understanding. In general, the sample students have an active character, are confident, curious, and enjoy exploring.

Furthermore, learning analysis and topic needs analysis were carried out. Basic Chemistry learning is carried out by blended learning, offline and online. This was done because it was adjusted to the Covid-19 pandemic situation while lecturers were required to complete study materials within the span of one semester. When learning is done online, the lecturer conveys it using the Problem Based Learning method. Meanwhile, when learning is done offline, it is done using the Team Games Tournament learning method. In basic chemistry learning, the topics to be studied are Atomic Structure, Periodic System of Elements, Stoichiometry, Acids and Bases Salts, Solutions, and Polymers and Composites. Based on the results of interviews with lecturers, the study materials were adapted to the needs of students as candidates for civil engineering degrees and delivered through a variety of learning models. Basic chemistry material is given to complement students' knowledge in terms of the chemical composition of materials. Based on the results of the observations and interviews, it was decided that the development of the learning syntax would be tested on the Acid Base Salt study material.

4.2. Product Development

After the preliminary analysis, the syntax design for chemistry learning was carried out. Based on the results of observations in preliminary research, the delivery of material in chemistry learning has never involved local wisdom or culture. So it was decided to develop an integrated chemistry learning syntax with ethno-STEM. The learning syntax that was developed was named the HENIE syntax. The syntax can be described as follows

H – Hearken
E – Exploration
N – Narrative
I – Implementation
E – Evaluation

At stage H (Hearken), students hearken to problems presented by lecturers.The problem presented by the lecturer is the culture that exists in Merauke Regency and its surroundings. It is at this stage that the ethnoscience aspect is included in learning. After the lecturer presents the problem, the lecturer invites students to enter the next stage, namely stage E (Exploration). The exploration stage is in the form of library research and interview activities about the problems presented previously. It is in this exploratory process that the STEM approach is included. In the exploration process, students are required to fulfill aspects of science, technology, engineering, and mathematics. For the scientific aspect, it is a scientific review of local wisdom which is the main topic of the problem. For the technological aspect in the form of using technology in the processing or making objects of local wisdom. Technological aspects can also be applied in the implementation phase. For the engineering aspect, it is a technical review or mechanics in the processing or making objects of local wisdom. For the mathematical aspect in the form of a mathematical review in the process of processing or making objects of local wisdom.

After students complete the exploration stage, students are directed to the next stage, namely N (narrative) stage. At the narrative stage, students summarize and compile the results of their exploration in the form of a written report or powerpoint slide. The format and systematics of the report can be discussed with the lecturer in charge of the course. After students complete their reports, they go to the next stage, namely I (Implementation). At the implementation stage, students present the results of the exploration that have been narrated in the form of writing or powerpoint slides. The use of technology at the time of implementation is one of the technological aspects of the STEM approach. After the implementation phase is complete, the lecturers and other students provide E (Evaluation) in the form of questions, rebuttals, sharing additional information, or strengthening the results of presentations that have been delivered by students.

4.3. Validation

After the learning syntax is developed, validation is carried out by experts. The validation results are shown in table 3.

Table 3. HENIE syntax development validation results

No	Aspect	Indicator	Average score	Category
1	Presentation of events or phenomena	Observation found problems	4,3	Very Good
2	Presentation of learning	Finding the hypothesis	4,0	Good
		Drawing conclusions and discoveries	4,4	Very Good

The validator gave a positive response and really appreciated the development of chemistry learning syntax. The validator conducted in-depth interviews with the researchers, after listening to a complete and comprehensive explanation, the validator gave a score on the aspects tested. Overall, the validator provides a value for the validity of the learning syntax developed in the very good category. This shows that the product is in accordance with its development goals.

4.4. Field Trial

The HENIE syntax that has been declared valid is then tested in small groups consisting of 1 teacher and 10 students. The test results in the form of an assessment of learning planning and an assessment of the implementation of the HENIE syntax are shown in table 4 and table 5.

Table 4. Result of Lesson Plan Assessment

No	Aspect	Score
1	Formulation of learning objectives	10
2	Formulation and organization of teaching materials	11
3	Determination of learning resources/media	11
4	Assessment of learning activities	10
5	Assessment of the learning process	9
6	Assessment of learning outcomes	9
	Total	**60**
	Lesson Plan AssesmentPercentage	**90,90%**

Table 4 shows the assessment of lesson plans by small groups of 11 people. The percentage of learning planning reaching 90.90% is in good category. In the assessment of the formulation and preparation of learning materials and the determination of learning resources/media received responses from 11 respondents. The assessment of the formulation of learning objectives and learning activities received responses from 10 respondents. The assessment of the learning process and learning outcomes received responses from 9 respondents. This shows that the assessment aspects of objective formulation and learning activities are not visible to the other 3 respondents.

The next step is to evaluate the learning implementation. The results of the learning implementation assessment are shown in table 5.

Table 5. Result of Learning Implementation Assessment

No	Aspect	Score
Preliminary activities		
1	Prepare students physically and psychologically in starting learning activities	11
2	Linking learning materials with local wisdom around student	11
3	Delivering competencies, goals, and activity plans	9
Core activities		
4	Learning materials according to indicators	11
5	Delivering learning strategies	10
6	Apply exploratory, elaboration, and confirmation learning	11
7	Use correct and appropriate language in narrative	11
8	Utilizing learning media resources in implementation	11
9	Involving students in the learning process	9
10	Be polite and courteous	11
Closing Activities		
11	Making evaluation by involving students	11
12	Doing reflection	10
13	Giving assignments as a form of follow-up	11
	Total	**137**
	Learning Implementation AssessmentPercentage	**95,80%**

Table 5 shows that the implementation of learning reaches 95.80%, which means it is in the very good category. 9 aspects were rated by all respondents, 2 aspects were rated by 10 respondents, and the other 2 aspects were only rated by 9 respondents. In delivering competencies, goals, and activity plans, it has been carried out but some respondents have shifted their concentration so that they do not listen carefully about the competencies, goals, and activity plans. As for the aspect involving students in the learning process, some respondents felt they were less involved in the learning process. In general, the implementation of learning using the HENIE syntax went well.

4.5. Implementation

The next stage is implementation. At the implementation stage, learning is carried out on the Acid Base Salt material using the HENIE syntax. Then students are given a test to measure their literacy and critical thinking skills. The results of the students' literacy and critical thinking skills are shown in table 6 and table 7.

Table 6. Result of Student Literacy Ability Assessment

No	Aspect	Average score	Percentage	Category
1	Explaining phenomena scientifically	4,50	75,00%	Good
2	Interpreting scientific data and evidence	6,50	72,22%	Good
3	Evaluating and designing scientific investigations	3,73	74,67%	Good

Table 6 shows that students' literacy skills after learning with HENIE syntax are in the Good category. This shows that the HENIE syntax can stimulate students' literacy skills. Students become interested in learning chemistry when it is associated with local culture, namely areca nut. Many things were initially thought by students to be commonplace in the activity of consuming areca nut, but it turns out that each stage can be explained scientifically and is related to chemistry.Holbrook &Rannikmae[24]argue that improving scientific literacy means developing students' ability to creatively utilize appropriate evidence-based scientific knowledge and skills, solve problems, and make responsible decisions.

Table 7. Result of Student Critical Thinking Assesment

No	Aspect	Indicator	Score
1	Understanding the problem	Using inductive or deductive reasoning	28
2	Making plans	Analyzing the interrelationships of each part of the whole to produce a complex system	25
3	Implement planning	Analyze and evaluate facts	24
4	Check again	Draw conclusions based on the results of the analysis	26
		Total score	**103**
		Critical Thinking Percentage	**85,83%**
		Category	**Good**

Table 7 shows that the students' critical thinking skills after studying the Acid Base Salt material using the HENIE syntax are in the percentage of 85.83% in the Good category. These results indicate that the HENIE syntax is effective in encouraging students' critical thinking skills in learning. Johnson[25]defines critical thinking as a directed and clear process used in mental activities such as problem solving, making decisions, persuading, analyzing assumptions and conducting scientific research. Critical thinking according to Reza [26]is the ability to argue in an organized way, the ability to systematically evaluate the weight of personal opinions from the opinions of others.

V. CONCLUSION

The results of the development of the HENIE syntax show that (1) the validation of the syntax product is in the Good and Very Good categories. The validator also gave a positive response to this research, (2) the percentage of lesson plan assessment of 90.90% was in the Good category, (3) the percentage of learning implementation assessment of 95.80% was in the very good category, (4) student literacy ability assessment is in the good category, and (5) the percentage of students' critical thinking skills reaching 85.83% is in the Good category.

REFERENCES

[1] Sudarmin, *Pendidikan Karakter, Etnosains dan Kearifan Lokal: Konsep dan Penerapannya dalam Penelitian dan Pembelajaran Sains.* Semarang: Fakultas Matematika dan Ilmu Pengetahuan Alam Universitas Negeri Semarang, 2015.

[2] N. S. E. Wiyanto and Hartono, "The Scientific Approach Learning: How Prospective Science Teachers Understand About Questioning," *J. Phys. Conf. Ser.*, vol. 824, no. 1, pp. 12–15, 2017.

[3] R. M. Lia, U. Wirda, and Mulyatun, "Pengembangan Modul Pembelajaran Kimia Berorientasi Etnosains dengan Mengangkat Budaya Batik Pekalongan," *Unnes Sci. Educ. J.*, vol. 5, no. 3, pp. 1418–1423, 2016.

[4] T. Mayasari, A. Kadarohman, and D. Rusdiana, "Pengaruh Pembelajaran Terintegrasi Science, Technology, Engineering, and Mathematics (STEM) Pada Hasil Belajar Peserta Didik : Studi Meta Analisis," 2014.

[5] Hikmawati, "Analisis Artikel Tentang Etnosains dan Kearifan Lokal Masyarakat Suku Sasak Untuk Mengembangkan Literasi Sains dan Literasi Budaya Mahasiswa," *J. Pendidik. dan Pengabdi. Masy.*, vol. 4, no. 3, 2021.

[6] Liliasari, "THE IMPROVEMENT OF TEACHER QUALITY ON HIGHER ORDER THINKING SKILLS THROUGH MODELS OF TEACHING IN SELECTED TOPICS OF CHEMISTRY FOR

SENIOR HIGH SCHOOL," *J. Pendidik. Mat. dan Sains*, vol. 3, no. 8, 2003.
[7] H. Patmawati, "ANALISIS KETERAMPILAN BERPIKIR KRITIS SISWA PADA PEMBELAJARAN LARUTAN ELEKTROLIT DAN NONELEKTROLIT DENGAN METODE PRAKTIKUM," UNIVERSITAS ISLAM NEGERI SYARIF HIDAYATULLAH, 2011.
[8] Sudarmin, *Pendidikan Karakter, Etnosains dan Kearifan Lokal: Konsep dan Penerapannya dalam Penelitian dan Pembelajaran Sains*. Semarang: Universitas Negeri Semarang, 2014.
[9] R. Duit and D. F. Treagust, "Conceptual Change: A Powerful Framework for Improving Science Teaching and Learning," *Int. J. Sci. Educ.*, vol. 25, no. 6, pp. 671–688, 2003.
[10] T. Perwitasari, Sudarmin, and S. Linuwih, "Peningkatan Literasi Sains Melalui Pembelajaran Energi dan Perubahannya Bermuatan Etnosains pada Pengasapan Ikan," *J. Penelit. Pendidik. IPA*, vol. 1, no. 2, pp. 62–70, 2016.
[11] A. Widiyatmoko, Sudarmin, and M. Khusniati, "RECONSTRUCT ETHNOSCIENCE BASED-SCIENCE IN KARIMUNJAWA ISLANDS AS A MODE TO BUILD NATURE CARE STUDENT CHARACTER," 2015.
[12] H. Wang, T. Moore, G. Roehrig, and M. Park, "STEM Integration: Teacher Perceptionsand Practice," *J. Pre-College Eng. Educ. Res.*, vol. 1, no. 2, pp. 1–13, 2011.
[13] T. R. Kelley and J. K. Geoff, "A Conceptual for Integrated STEM Education," *Int. J. STEM Educ.*, vol. 3, no. 11, pp. 1–11, 2016.
[14] M. Sanders, "STEM, STEM Education, STEM Mania," *Technol. Teach.*, vol. 68, no. 4, pp. 20–26, 2009.
[15] R. Zalsalina and P. Angin, "Penerapan STEM Pada Pembelajaran IPA Materi Bioteknologi," 2020.
[16] Y. Yuliati, "Literasi Sains Dalam Pembelajaran IPA," *J. Cakrawala Pendas*, vol. 3, no. 2, pp. 21–28, 2017.
[17] W. S. Winkel, *Psikologi Pengajaran*. Yogyakarta: Media Abadi, 2007.
[18] C. Perkins and E. Murphy, "Identifying and Measuring Individual Engagement in Critical Thinking in Online Discussions: An Exploratory Case Study," *Educ. Technol. Soc.*, vol. 9, no. 1, pp. 298–307, 2006.
[19] M. A. A. Kadir, "Critical Thinking: A Family Resemblance in Conceptions," *J. Educ. Hum. Dev.*, vol. 1, no. 2, 2007.
[20] Sugiyono, *Educational Research Methods: Quantitative Approach, Qualitative, and R & D*. Jakarta: Alfabeta, 2015.
[21] R. Asyhar, *Kreatif Mengembangkan Media Pembelajaran*. Jakarta: Referensi Jakarta, 2012.
[22] M. Betaubun, H. P. Asmaningrum, and Nasrawati, "Improving Digital Learning Tool in the Classroom through Interactive Bilingual Ebook Based On Local Wisdom of Indonesia," *Am. J. Humanit. Soc. Sci. Res.*, vol. 4, no. 6, pp. 292–302, 2020.
[23] Djaali and P. Muljono, *Pengukuran Dalam Bidang Pendidikan*. Jakarta: PT Grasindo, 2008.
[24] J. Holbrook and M. Rannikmae, "The Meaning of Scientific Literacy," *Int. J. Environ. Sci. Educ.*, vol. 4, no. 3, pp. 275–288, 2009.
[25] E. B. Johnson, *Contextual Teaching and Learning: What It Is and Why It's Here to Stay*. United States of America: Corwin Press, INC, 2002.
[26] R. Rachmadtullah, "Kemampuan Berpikir Kritis dan Konsep Diri dengan Hasil Belajar Pendidikan Kewarganegaraan Siswa Kelas V Sekolah Dasar," *J. Pendidik. Dasar*, vol. 6, no. 2, pp. 287–298, 2015.