Analysis of the Application of STEM with an Ethnoscience Approach by Chemistry Teachers in West Nusa Tenggara

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Abstract. This study aims to analyze the application of STEM (Science, Technology, Engineering and Mathematics) with an ethnoscience approach to chemistry learning in West Nusa Tenggara (NTB). It is qualitative research using a questionnaire technique to assist in obtaining relevant information. The total sample comprised 113 chemistry teachers whose educational background, gender, age, school type, school location, employment status, teaching experience, and academic qualifications in the field of science. The total teaching load per week and participation in teacher certification were taken into account. The results show that most of the chemistry teachers in NTB had not applied STEM with an ethnoscience approach to the chemistry learning process, and cultural aspects had not been used in the implementation of classroom and laboratory work learning. The results of the study show that most chemistry teachers in NTB have not implemented STEM with an ethnoscience approach in the chemistry learning process and laboratory work. All chemistry teachers in NTB hope that models and modules will be developed to assist them in implementing STEM with such an approach.

Keywords: TEM · ethnoscience · West Nusa Tenggara · chemistry teachers

1 Introduction

Since 2013, Indonesia has implemented the K-13 curriculum at all levels of education. The reconstruction was conducted based on competency, content, graduate competency, and assessment standards. This resulted in changes in the learning process, with more emphasis on contextual learning and fun for students. In addition, important cultural aspects were integrated into the learning process to maintain the identity of the Indonesian nation and shape the character of students.

The current reconstruction of the chemistry curriculum has also changed since the implementation of K-13. If chemistry was previously the main subject, it has now become a specialized subject that can provide opportunities for students to develop their interests according to their wishes when choosing a chemistry major in higher education. It is a challenge for chemistry teachers to provide learning opportunities that can spark students' interest in learning the subject.

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Chemistry is currently still a subject that is less attractive to students. Browman et al. [1] report that 372 middle school students gave negative responses to chemistry-related issues, while questionnaire analysis on 773 high school students showed negative responses to chemistry lessons [2]. Participants in the national examination for chemistry in Mataram city fall every year by a percentage of less than 25%. This can, of course, affects the number of students majoring in chemistry at the university level.

The low student interest in chemistry is caused by several factors. One of them is the difficulties experienced in studying the subject because explanations that always begin with microscopic aspects without showing macroscopic aspects lead to abstract chemical content [3, 4]. The macroscopic aspect can give a meaningful impression of chemistry [5]. In addition, chemical content is not linked to student life, making students feel that it is irrelevant and has little use for their lives [6, 7].

STEM is an effort to combine science, technology, engineering, and mathematics in lessons that connects students with the real world [8]. The application of STEM not only makes students interested in the learning that is taking place, but it also increases the professionalism of teachers as educators [9–11]. Integrating STEM into the chemistry curriculum needs to start now to change students' views of the subject and to increase teacher professionalism, enabling them to educate students through chemistry [12].

The ethnoscience approach aims to connect the application of science to people's lives so that science and culture are connected in shaping the character of students [13]. The lack of a cultural approach causes students to be unfamiliar with the culture of their environment, whereas local practices and perceptions can build students' attitudes and skills because their learning is connected with the life around them [14]. Ibe and Nwosu's [15] research uses an ethnoscience approach to improve students' processing skills.

The ethnoscience approach can have a big influence on the field of education. Apart from bringing students closer to real life, a cultural approach can introduce and teach cultural values and their role in education. Such values can create and develop a meaningful learning and teaching atmosphere [14]. In Lombok, many hereditary cultures and habits can be used as learning materials, especially with the use of simple technology. However, until now, the learning model developed by exploring Lombok culture has yet to be widely used, especially for learning chemistry.

Learning with a cultural approach has many benefits for students. Rist and Dahdouh-Guebas [14] categorize the benefits of ethnoscience into three main benefits: creating awareness to explore culture through stakeholders and other social communities, contributing by preparing forums to help solve social problems, and playing an active role in the social process to assist stakeholders in formulating policies and implementing them.

The application of STEM with an ethnoscience approach can be employed in chemistry learning through the development of models or other learning resources. Model development requires an analysis phase that describes the need to apply such an approach. This study aims to analyze the application of STEM with an ethnoscience approach to chemistry learning in NTB.

2 Methods

2.1 Type of Research

The research employs a qualitative method to study the application of STEM with an ethnoscience approach in NTB. The technique used was a questionnaire to assist in obtaining relevant information. According to Wellington [16], a questionnaire is an effective instrument for collecting data in such research.

2.2 Participants

The study participants were chemistry teachers working in secondary schools in West Nusa Tenggara. The total sample was 113 teachers, with their various educational backgrounds, gender, age, school type, employment status, teaching experience, academic qualifications, fields of knowledge, total teaching load per week, and participation in teacher certification taken into consideration. The sample details are shown in Table 1.

2.3 Instrument

The instrument used was a questionnaire with three indicators, namely:

1. Preparation for the implementation of learning according to K-13.
2. Implementation of learning with STEM and ethnoscience approaches.
3. Implementation of assessment.

Each indicator was developed into several statements with four answer choices: never implemented; has been discussed; planned to be implemented; has been done.

The instrument developed was analyzed by three experts using the Aiken agreement index to determine if it was suitable for use as a measuring tool. The Aiken index results showed an average rating of 0.869, indicating that the instrument was suitable for use. Instruments deemed appropriate were compiled in Google Forms and sent to the chemistry teachers in West Nusa Tenggara.

2.4 Data Analysis

The average of each statement for each indicator was tabulated and the percentage was calculated. The free data responses provided by each respondent were grouped into categories and described.

Table 1. Summary of sample demographics

Identity	Sum	%	Identity	Sum	%
School Type			*Teaching Experience (yrs)*		
Public MA	6	5.31	1–5	21	18.58
Private MA	2	1.77	6–10	15	13.27
Public SMA	67	59.29	11–15	49	43.36
Private SMA	14	12.39	16–20	14	12.40
Public SMK	14	12.39	21–25	8	7.08
Private SMK	3	2.65	26–30	5	4.43
Public SMP	7	6.20	31–35	1	0.88
School Location			*Level of Education*		
Undeveloped regions	4	3.54	Undergraduate	90	79.60
In the City	58	51.33	Master	23	20.40
Village	33	29.20			
Country Side	18	15.93			
Age			*Academic Qualification*		
24–28	6	5.31	Chemistry	14	12.40
29–33	20	17.70	Chemistry Education	83	73.45
34–38	30	26.55	Science Education	13	11.50
39–43	41	36.28	Non-Chemistry	3	2.65
44–48	9	7.96			
49–53	7	6.20			
Gender			*Total Teaching per Week (hours)*		
Male	28	24.78	<5	3	2.66
Female	85	75.22	5–10	6	5.31
			11–15	21	18.58
			16–20	4	3.54
			21–25	63	55.75
			25<	16	14.16
Employment Status			*Teacher Certification*		
PNS	34	30.09	Yes	72	63.72
Non PNS	79	69.91	Not yet	41	36.28

3 Results and Discussion

3.1 Results

Analysis of the questionnaire indicators regarding learning preparation according to K-13 shows that the percentages varied for all statements. 79.65% of teachers have compiled a chemistry syllabus according to the K-13 curriculum; 63.03% have deepened basic competencies and content standards according to students' chemistry learning needs; 61.95% have developed basic competencies and content standards according to student characteristics in chemistry learning; 76.99% have developed several indicators in the

Table 2. Chemistry teacher responses to implementation of learning preparation according to k-13

No	Statement	Responses (%)			
		1	2	3	4
1.	I prepare a chemistry syllabus according to the K-13 curriculum.	0.89	9.73	9.73	79.65
2.	I deepen basic competencies and content standards according to the needs of students in learning chemistry.	3.54	10.62	16.81	69.03
3.	I deepen basic competencies and content standards according to student characteristics in chemistry learning.	2.65	14.16	21.24	61.95
4.	I am developing a number of indicators in the syllabus that reflect the achievement of competencies in chemistry learning.	2.66	6.19	14.16	76.99
5.	I prepare teaching plans for each implementation of chemistry learning.	1.77	4.43	7.96	85.84
6.	In the lesson plans that I compiled, the learning objectives reflect the achievement of basic indicators and competencies.	1.77	3.54	7.08	87.61
7.	I organize chemistry learning materials in order to achieve competency.	2.65	5.31	12.39	79.65

Note: (1) has never been implemented; (2) has been discussed; (3) planned to be implemented; (4) has been implemented

syllabus that reflect the achievement of competencies in chemistry learning; 85.84% of teachers have compiled lesson plans; 87.61% of the lesson plans have been prepared by the teacher, with the learning objectives reflect the achievement of basic indicators and competencies; and 79.65% of teachers have organized chemistry learning materials to achieve the required competencies. The percentages of teacher responses to the first indicator are shown in Table 2.

It is shown that most teachers have not implemented STEM learning and the ethnoscience approach. 69.03% of teachers have used various learning methods; only 8.85% of teachers have conducted chemistry laboratory work according to the characteristics of the given topic and have provided feedback; 9.74% have undertaken laboratory work learning by utilizing the surrounding environment; 12.39% have included the surrounding culture (historical objects or community habits) in the chemistry learning process; 35.4% have implemented chemistry lessons that build student character; 9.74% have used simple science in the community in chemistry learning in class and lab work, and 49.56% of chemistry teachers have used text/modules. The teacher responses to the implementation of learning with STEM and ethnoscience education are shown in Table 3.

Table 3. Responses of chemistry teachers to learning implementation with stem and ethnoscience approach

No	Statement	Responses (%)			
		1	2	3	4
1.	I use a variety of learning methods that are oriented toward achieving the goals of learning chemistry.	0.89	6.19	23.89	69.03
2.	I carry out chemistry lab work according to the characteristics of the topics being taught.	35.40	42.48	13.27	8.85
3.	I provide feedback on the implementation of chemistry laboratory work.	37.17	22.12	31.86	8.85
4.	I carry out chemistry laboratory work by utilizing the surrounding environment.	34.51	23.01	32.74	9.74
5.	I use the surrounding culture (historical objects or community habits) in the chemistry learning process.	34.51	23.01	32.74	9.74
6.	I carry out chemistry lessons that build student character.	32.74	9.74	22.12	35.40
7.	I use simple science that exists in society in learning chemistry in the classroom.	41.59	22.12	26.55	9.74
8.	I use simple science in society in the chemistry lab.	38.05	25.66	26.55	9.74
9.	I use a module in chemistry learning.	22.12	7.97	20.35	49.56

Note: (1) has never been implemented; (2) has been discussed; (3) planned to be implemented; (4) has been implemented

Table 4. Chemistry teachers' responses to the implementation of assessment

No	Statement	Responses (%)			
		1	2	3	4
1.	I use product-based assessment in chemistry learning.	24.78	10.62	28.32	36.28
2.	I use performance-based assessment in chemistry learning.	9.73	10.62	19.47	60.18
3.	I use project-based assessment in chemistry learning.	26.55	12.39	21.24	39.82
4.	I use portfolio-based assessment in chemistry learning.	0	0	20.35	79.65

Note: (1) has never been implemented; (2) has been discussed; (3) planned to be implemented; (4) has been implemented

The assessment implementation indicators show that the performance and portfolio-based assessments are those with the highest percentage that are conducted by teachers. Product and project-based assessments have yet to be widely applied by teachers (Table 4).

Furthermore, an opinion poll was conducted regarding the development of a STEM-based chemistry learning model with an ethnoscience approach. The poll results show that 74.34% of teachers think it is necessary to develop a chemistry learning model that can build student character, 71.68% think it is very necessary to develop STEM in chemistry learning, and 53.98% need to include culture in chemistry learning.

The free-response data show that five types of suggestions/input were given by the chemistry teachers:

1. It is necessary to develop a culture-based chemistry learning model to increase students' interest in learning chemistry.
2. STEM with an ethnoscience approach needs to be applied to understand the concept of chemistry related to the environment.
3. It is necessary to develop models and modules related to STEM with an ethnoscience approach.
4. It is necessary to develop practical instructions related to the implementation of chemistry laboratory work with simple materials.
5. The formulation of the model should take into account the stimulus stage, the method used, the skills to be developed, and the possible stages of applying STEM with an ethnoscience approach.

3.2 Discussion

The analysis in this study illustrates that STEM with an ethnoscience approach has not been widely applied by chemistry teachers in NTB. The data aim to provide information that could be useful in determining strategies or programs for implementing such an approach. In addition, the analysis of the data could be a guide for instructors to improve the learning process by utilizing STEM in line with current conditions [17].

STEM is intended as a learning process related to the context of problems, assignments, and projects to train students in developing ideas [10, 11], a process that has begun to be developed to increase students' interest in learning. However, the application of STEM in chemistry learning is relatively rare [18].

Community habits and the surrounding culture can be sources for learning chemistry by applying STEM. In addition to bringing students closer to their environment, the ethnoscience approach can improve process skills and build student character [15]. Following the suggestions given by chemistry teachers, the importance of learning implementation can bring students closer to their environment.

The results of the questionnaire analysis provide clues to several issues that need to be developed in the application of STEM with an ethnoscience approach. Overall, the chemistry teachers have prepared lesson plans and organized subject matter according to student needs. The learning methods used have varied, although some teachers have only just started applying various methods for learning chemistry.

The application of STEM with an ethnoscience approach for chemistry teachers can start with the development of a related STEM-based learning model. This model should be focused on developing assignments or projects that can provide opportunities for students to develop ideas with an ethnoscience approach to their stage of learning. Cultural aspects that can be used include historical objects, norms, values, community habits, and simple technology. This approach can educate students about maintaining their culture [15]. The aspects to be used must be adjusted to the chemistry material being taught, while teachers need to undertake exploration to determine the suitability of the material and learning resources to be used.

Such a STEM approach can combine several learning methods; the application of student-centered learning methods is in line with the K-13 curriculum. Teachers can emphasize problems, assignments, and projects to train students to develop ideas [10, 11]. Cultural aspects can be given at the orientation and reflection stages to motivate students and convey the moral values of each culture used [19, 20].

One of the learning methods that can be used in the application of STEM with an ethnoscientific approach is laboratory work or inquiry. Laboratory-based learning includes student-centered learning, which can be used in the application of STEM [21]. Project delivery through inquiry can be effective when using peer tutors or working in groups [21, 22].

Model and module development needs to be conducted to make it easier for teachers to apply STEM in this way. The models developed should contain learning stages that describe the activities undertaken by teachers and students, as well as relevant learning tools. Modules can be developed to make it easier for teachers to choose teaching materials and cultural resources related to STEM and ethnoscience.

As previously stated, chemistry teachers provide input regarding the preparation of a learning model that applies STEM with an ethnoscience approach. The teacher's input stage is the stimulus stage at the beginning of the lesson, which can trigger student interest and provide motivation to explore the content to be studied [23–25]. The orientation stage can be used by teachers to convey cultural aspects using videos, pictures, or stories found in local communities. At this stage, the teacher can also relate these cultural aspects to the material to be delivered. The connectivity of cultural aspects with teaching material can be effective if the orientation stage is successful. This needs to be considered in designing activities at the orientation stage, in addition to explaining the objectives and stages of learning to be conducted [26–28].

The method used needs to be an important concern in designing chemistry learning models that apply STEM with an ethnoscience approach. STEM emphasizes problem content and provides the widest possible opportunities for students to develop ideas [29, 30]. Several learning models can be developed, such as inquiry and cooperation. Inquiry is an activity that can provide students with opportunities to develop ideas and ideas [31, 32]. Inquiry is divided into four levels, namely verification, structured inquiry, guided inquiry, and open inquiry [33]. Although it is reported to be able to improve student understanding, the use of inquiry needs to consider the characteristics of the material being taught and the student's level of thinking [34–36]. It can be applied in stages, starting from the lowest level of inquiry, namely verification, up to higher levels [37, 38].

Cooperative is a model that can be used in chemistry learning with the application of STEM. A group's ability to discuss becomes the mouthpiece for improving the learning process. One cooperative model that can be applied in STEM is peer-led team learning [22]. This model prioritizes support and good cooperation between group members [39, 40]. The strength of the model is the leader's ability to help his/her friends understand the concept [41, 42]. Of course, cooperative learning can be connected with people's habits related to cultures that need to be maintained.

The application of STEM with an ethnoscience approach is expected to train skills that can be useful for student career development. STEM in chemistry learning focuses on students' critical thinking skills as an aid in facing life's challenges ahead [43]. Apart from critical thinking skills, communication skills can also be developed through the application of STEM. If STEM can train many skills, then the ethnoscience approach can train attitudes, which constitute the accompanying impact of trained skills [44]. The integration of skills and attitudes can produce meaningful learning [45–47].

4 Conclusion

The results show that most chemistry teachers in West Nusa Tenggara have not applied stem with an ethnoscience approach to the chemistry learning process. Not many chemistry teachers have used cultural aspects, either in the implementation of the classroom or in practical learning. All chemistry teachers in West Nusa Tenggara hope that models and modules will be developed to assist them in implementing this approach; such models need to pay attention to the stages of the model, the methods used, and the skills to be trained.

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