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The prospective ethnopedagogy-integrated STEM learning approach: science teacher perceptions and experiences

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Abstract. Regarding the 4.0 industrial revolution, the STEM dimension is very important. Separately, the facts related to the development of ethnoscience in Indonesia are also very closely related to the student learning environment. STEM can play a role as an 'engaging tools' in local wisdom-based learning. However, there is no 'something' to integrate these dimensions. In this case, this study is focused on developing a preliminary form of product. We design the working framework of ethno-pedagogy-integrated STEM learning approach based on science teacher perception and experience. This study was carried out using a mixed method with a survey and analysis document on science teacher learning tools. The survey results showed that the teacher had utilized several ethno potentials that have developed in the community. The results of the document analysis have resulted in the finding that most teachers did not have a pattern yet for applying STEM learning that was related to local wisdom in their society. The ethnoscience facts that existed in the community from the survey results that had a big local potential to be integrated into STEM learning, for example, could be seen from the many traditional buildings and dances (Physics) and traditional food (Bio-Chemistry).

1. Introduction

Ethnopedagogy could be defined as the actualization of learning-oriented to the inculcation of local wisdom values. Ethnopedagogy could be considered as the actualization of learning-oriented to the inculcation of local wisdom values. Ethnopedagogy can be seen as an educational practice based on local wisdom and sourced from the cultural values of an ethnic group and a standard of behavior. Indonesians generally believe that schools are strong institutions in transforming culture into future generations, even though in reality cultural transformation occurs more frequently than social interactions or contacts between students and communities outside the school [1]. The use of ethnopedagogy has positively influenced the development of the physical, emotional and communicative environment [2]. The roles of ethnopedagogy in education, especially in learning for students in Indonesia cannot be separated, considering that each region in Indonesia has different cultural characteristics.



Several papers widely investigated the emergence, contribution, and impact of global issues such as the industrial revolution 4.0 [3, 4, 5] and society 5.0 [6, 7]. After we explore, the variables that bridge the two latest issue trends are the science-sociocultural dimension [8, 9], where these dimensions can be linked to the concept of ethnopedagogy itself, how the culture in the surrounding environment including local potential can be integrated into learning and become an experience meaningful learning for students. Correspondingly, in the world of education is also being muted with the STEM learning approach [10, 11, 12]. Several studies have shown that STEM can facilitate students to develop the 21st century STEM competencies [13, 14, 15, 16, 17], the role of STEM could scaffold students to gain learning experiences at a higher stage and is in line with the concept of IR 4.0 [18, 19, 20]. Even the STEM approach to learning has far greater potential and prospects in the future [21].

Considering the abundance of local wisdom in Indonesia, however, it is unfortunate that no one has yet discussed how the integrated STEM dimension and the concept of ethnopedagogy can be integrated and applied in learning. No research outside Indonesia maps how the STEM approach is applied in learning if it is integrated with the ethnopedagogy concept based on science teacher's perceptions and experiences. In this study, we describe science teacher's perceptions and experiences related to the concept of the Ethnopedagogy-Integrated STEM Learning Approach, and we also investigate the working framework of the ethnopedagogy-integrated STEM learning approach based on science teacher perception and experience. We conducted this research as an effort to utilize local wisdom in Indonesia into learning so that it can be in line with technological developments and science.

2. Method

The methods of this research is mixed-method on science learning lesson plan, media, and tools. In this case, this study is focused on developing a prospective hypothetical model of the Ethnopedagogy-Integrated STEM Learning Approach based on science teacher's perceptions and experiences. This research was conducted in two phases of surveying and document analysis, then development. We involved 105 science teachers of urban and remote areas in Bandar Lampung City, Indonesia with a long-range of teaching that varies like in Table 1.

Table 1. Sample Distribution

Years of Teaching Experience	Percentage of Sample	Criteria
0-1 years	23,8%	Beginner Science Teachers (BST)
2-9 years	4,7%	Junior Science Teachers (JST)
10-15 years	33.5%	Senior Science Teachers (SST)
16-20 years	19.0%	
21-25 years	4.7%	
26-30 years	14.3	

In the first phase, we collected data using a web-based survey using the Etnopedagogy-STEM Questionnaire that we develop to map the perceptions and experiences of teachers towards the ethnopedagogy-integrated STEM learning approach. We used descriptive analysis technique to explore trends in science teachers' perceptions of the ethnopedagogy and STEM approaches. Then we continued to the 'case study' approach [22, 23] by analyzing the documents used by science teachers in learning, including the media and tools used. Our 'case' is learning patterns or sequential learning from the integration of the ethnopedagogy-integrated STEM approach dimension by considering futuristic aspects of the science teacher's learning unit. The data were analyzed using a document-analysis method [24]. Document analysis is part of a raft of methodological approaches that come under the umbrella term of 'discourse analysis'. Discourse analysis aims to investigate the social meanings inherent in spoken language, images, and text. Document analysis focused on illuminating

the themes and ideologies which give meaning to pieces of writing or documents [24]. In the second phase, we ultimately produced a hypothetical model of the Ethnopedagogy-Integrated STEM Learning Approach based on survey and document-analysis findings.

3. Result and Discussion

3.1. Science Teacher's Perceptions

In the first step, we conducted a web-based survey based on some indicators and descriptors related to teacher's perceptions and experiences related to the implementation of ethnopedagogy-integrated STEM learning approach. The indicators were illustrated in Figure 1. Survey findings on teacher perceptions and experiences about the ethnopedagogy-integrated STEM learning approach were detailed in Table 2.

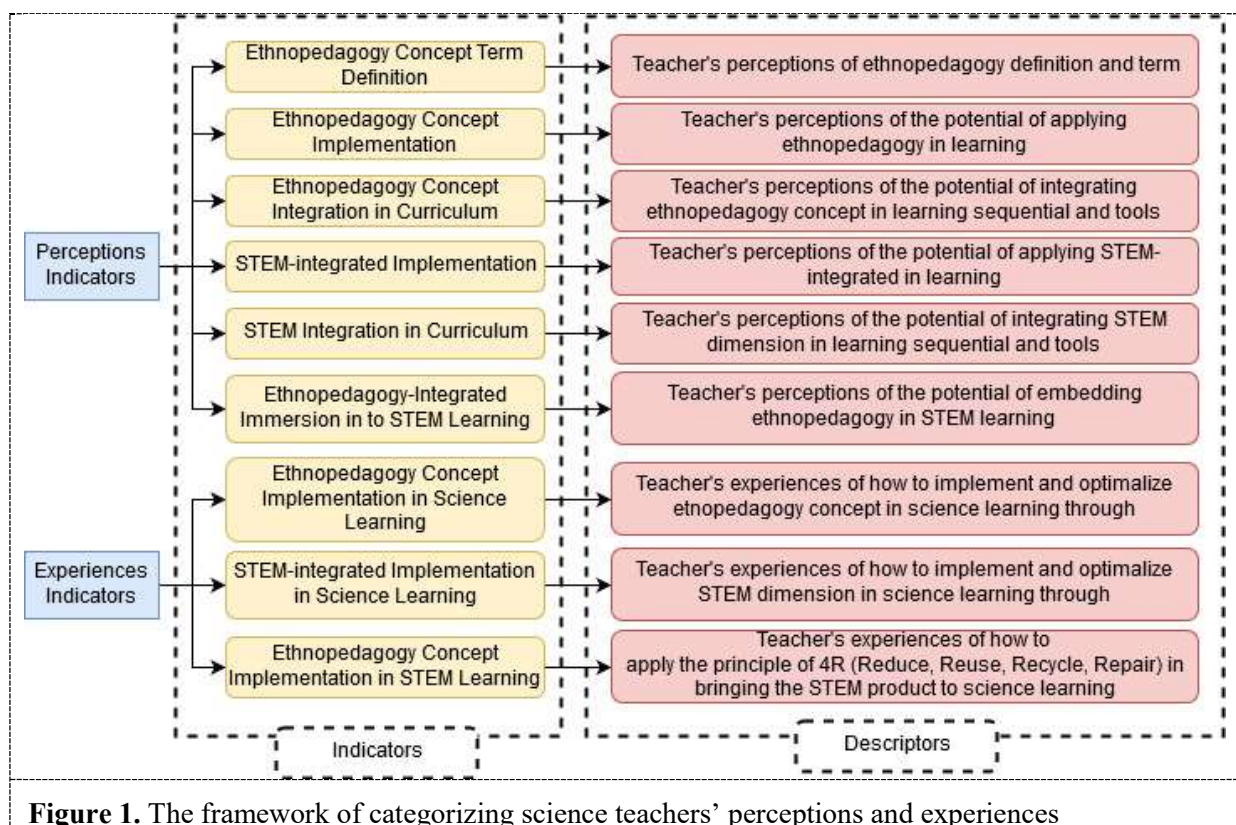


Figure 1. The framework of categorizing science teachers' perceptions and experiences

Table 2. Survey results of science teacher's perceptions about ethnopedagogy-integrated STEM learning approach

Indicator	Categorized Findings
Ethnopedagogy concept and term definition	85.7% of teachers understand about the ethnopedagogy concept Some definitions that teachers state about ethnopedagogy. Ethnopedagogy is a. Class management based on local wisdom. b. Take advantage of local potential in learning.

	<ul style="list-style-type: none"> c. Actualization of learning-oriented to the inculcation of local wisdom values. d. Education-based on local wisdom. e. Education based on the cultural values of local communities f. How to teach a science by using or utilizing local potential. g. Teaching students with certain peculiarities. h. The practice of education based on local wisdom in various fields. i. The art of being a teacher for learning strategies.
Ethnopedagogy concept implementation	<p>95.2 % of teachers believed that the potential and local wisdom in every region in Indonesia can be utilized in science learning.</p> <p>Some of the values of local wisdom that exist in Indonesia, especially Lampung, exemplified by teachers were:</p> <ul style="list-style-type: none"> a. Making traditional foods such as <i>tempoyak</i>. b. Traditional buildings and dances. c. The character of students and teachers who love the environment to participate in reducing global warming such as in the Pahawang area, Lampung. The community uses 3 solar cells in each house to meet their daily electricity needs to save energy.
Ethnopedagogy concept integration in curriculum	81% of teachers stated that the concept of ethnopedagogy could be very integrated in science learning.
STEM-integrated implementation	<p>85.7% of teachers stated that STEM dimensions (STEM 2.0, STEM 3.0, STEM 4.0) has enormous potential and contribution in learning science.</p> <p>Some futuristic aspects according to science teachers that can be raised if STEM is integrated in learning were:</p> <ul style="list-style-type: none"> a. Mastery of 21st-century skills (problem-solving, decision making, creative thinking, critical thinking, collaboration, communication) by students. b. Aligning learning with the industrial revolution (IR) era 4.0. c. Armed with mastery of the elements of STEM education, accompanied by high and broad imagination, students have the potential to think innovatively in real-life problems and far ahead.
STEM integration in curriculum	57.1% of teachers stated that the STEM dimension could be immersed in science learning.
Ethnopedagogy-Integrated Immersion into STEM Learning	85.7% of teachers stated that the concept of ethnopedagogy could be very integrated into STEM learning.

Survey results based on indicators in Table 2 described some pieces of evidence that lead to the good perceptions of teachers related to ethnopedagogy-integrated STEM as a learning approach. The results showed positive responses from BST, JST, and SST to the existence of ethnopedagogy-integrated STEM learning approach. Few BST teachers had constructed relevant conceptual frameworks that the concept of the STEM and ethnopedagogy approach was a new topic, whereas the concept of the STEM [25-27] and ethnopedagogy [28-29] had been widely investigated long years ago. However, we found JST and SST teachers' possible combinations of perception systems among STEM learning, project-based learning [30-33], and problem-based learning [34-36]. Whereas the application of the STEM approach in learning does not have to produce output in the form of certain products or tools [37]. This data provides a simple analysis of teachers' perceptions and teaching experiences. We have

an assumption that long experience of teaching can be a determining factor in BST teacher's perception.

3.2. Science Teacher's Experiences

Furthermore, survey findings on teacher's experiences about the implementation of the immersion of the ethnopedagogy-integrated STEM learning approach were detailed in Table 3.

Table 3. Survey results of science teacher's experiences about ethnopedagogy-integrated STEM learning approach implementation in learning

Indicator	Categorized Findings
Ethnopedagogy Concept Implementation in Science Learning	<p>95.4% of teachers stated that they already embedded ethnopedagogy concept in science learning.</p> <p>Examples of the potential or local wisdom that teachers use in learning science were:</p> <ol style="list-style-type: none"> Living environment and traditional biotechnology. Natural potential in the surrounding environment, such as the beach. The location of the school in a village surrounded by rice fields, rubber plantations, and residential areas makes it possible for students to observe and examine the surrounding nature directly. The environment around agriculture and animal-based schools. Much of the agricultural and livestock waste generated can be used to be processed into alternative renewable energy sources, such as biogas to overcome the scarcity of fuel and gas. Agriculture, plantations, and livestock manure. In biotechnology KD, students are asked to try to make <i>tempe</i> from soybean material that is easily available in their environment which was a <i>tempe</i>-producing area. Using the diversity of flora and fauna that are unique and exist in the surrounding environment in learning the breeding of plants and animals. Disaster literacy is integrated in the learning process, because school and home environment were included in disaster-prone areas. Utilizing the potential of rice fields around the school for learning ecosystems. Processing of fruits and local medicinal plants which are indeed widely grown in the home and school environment. Development of the cocoa plantation model, because the school environment is a cocoa-producing area.
STEM-integrated Implementation in Science Learning	<p>56.5% of teachers stated that they already implemented STEM-based learning to study science.</p> <p>Some STEM products that students produced in science classes that were taught by SST were:</p> <ol style="list-style-type: none"> Model of animal cells and plant cells made of plasticine and styrofoam used in electronic devices. Mini-hydro power plant. Simple clean water filtration. Simple electroscope. <i>Simple Harmonica</i>.
Ethnopedagogy	65.2% of teachers stated that they have utilized local potential to be

Table 3. Survey results of science teacher's experiences about ethnopedagogy-integrated STEM learning approach implementation in learning

Indicator	Categorized Findings
Concept Implementation in STEM Learning	<p>integrated into STEM-based learning.</p> <p>Examples of STEM products that students produce by utilizing the local potential of the science class that SST teaches were :</p> <ol style="list-style-type: none"> Living Power Plant Coastal ecosystem model Make a typical sweet potato donut Making various kinds of candied local fruits A simple rice field water purifier Making regional specialties with biotechnology

Survey results based on indicators in Table 3 especially for the indicator of ethnopedagogy concept implementation described some pieces evidence that most of JST and SST have utilized the potential or local wisdom in their area in learning science, this was indicated by the various products produced by students which more leads to the utilization of resources in their area. The rest of the science teachers who have not utilized the potential and local wisdom are BST, they stated unequivocally that they had not produced products in science learning because of lack of experience. For these teachers, their beliefs of teaching, learning and science, in some way showed some linkages. Similar results are shown by the second and third indicators, the data provides a simple analysis of students' learning output relationships and teaching experiences [38]. It is interesting to find that STEM-integrated implementation in science learning and ethnopedagogy concept implementation in STEM learning is tended to be found in teachers of greater teaching experience. For example, among the five of the most junior science teachers (i.e., less than 4 years of teaching), only two showed the ethnopedagogy product in STEM learning. However, the rest were found at eight among the 11 teachers of 10-13 years of teaching, and four among the five of the most senior teachers (i.e., more than 13 years of teaching). The success of JST and SST in directing students to produce STEM integrated ethnopedagogy products is not necessarily without the role of the teacher professional development program, which is first followed by more senior teachers [39].

3.3. Document-Analysis

Furthermore, our analysis continues to a higher level, 'a document-analysis'. We conduct a study of a series of learning tools including lesson plans and learning media developed by teachers and become a reference in teaching. Our document analysis was addressed in such a way to get findings, we used PCK [40] like in Figure 2. First, we identified whether the lesson plan developed by the teacher had fulfilled good PCK mastery indicators. Second, we identified whether the lesson plan that the teacher has developed is a sample lesson plan for science courses within the STEM education. Third, we identified the extent to which the ethnopedagogy content was integrated into learning. Finally, we made a hypothetical model based on the findings we obtained, namely Prospective Ethnopedagogy-Integrated STEM Learning Approach.

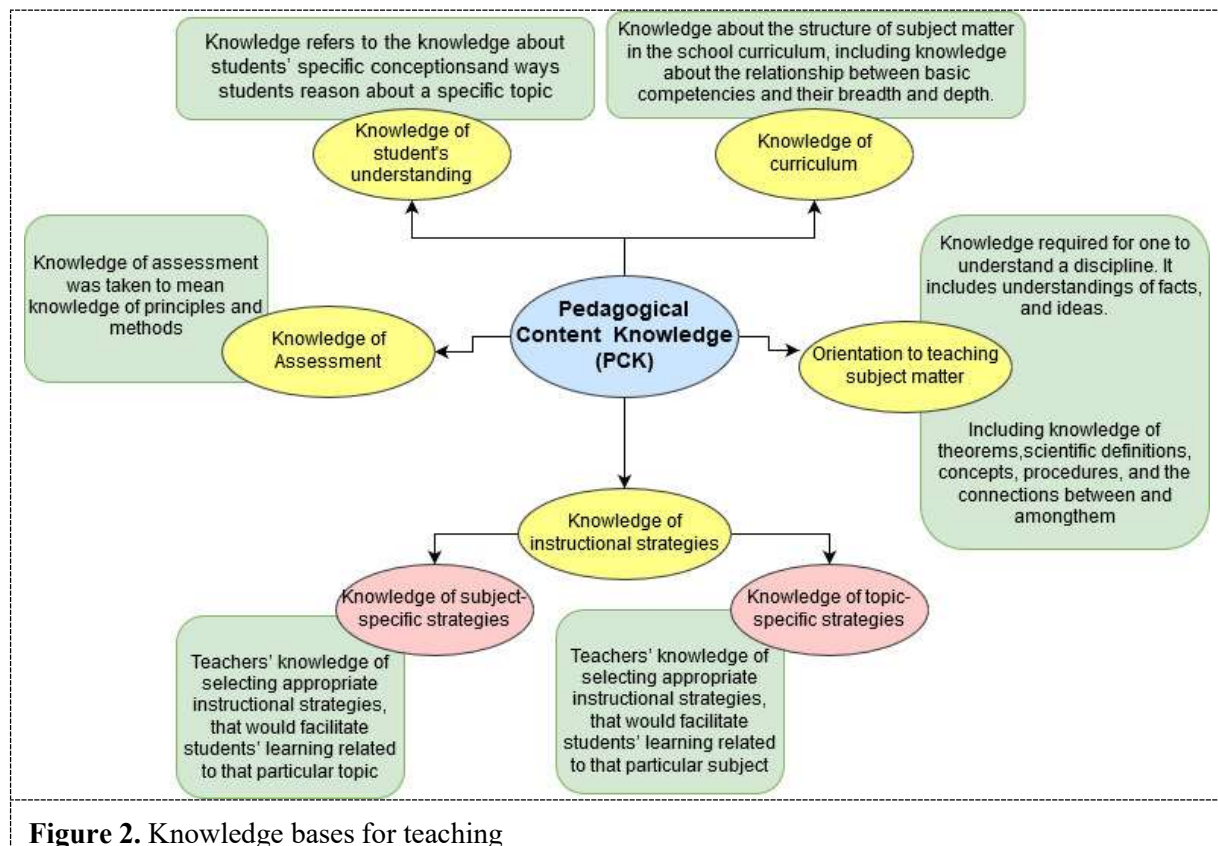


Figure 2. Knowledge bases for teaching

3.3.1 The case of teacher's PCK in lesson plan

The teacher's knowledge of student's understanding illustrated in the lesson plan showed that the teacher lacks Knowledge to make appropriate decisions for helping and guiding students in their knowledge construction certainly requires an understanding of student ways of thinking. It is not clear what form of assistance or guidance the teacher provides to students. The teacher only reveals that students must carry out certain activities to understand certain concepts, but the teacher does not provide a description of the type of scaffolding given, whether hard scaffolding [41] or soft scaffolding [20] or both [42]. Even in apperception activities, there were no learning activities that lead to the identification of students' way of thinking. An example of findings was shown in Figure 3.

Even though, a teacher who pays attention to where the students are conceptually can challenge and extend student thinking and modify or develop appropriate activities for students. Starting from students' limited conceptions, the teacher can help build more sophisticated ones [43]. Besides that, there are still many teachers who are stuck in the habit of providing stimulus with closed-ended problems, whereas to help students become critical and creative students need open-ended problem assistance in triggering active involvement in the learning process [44].

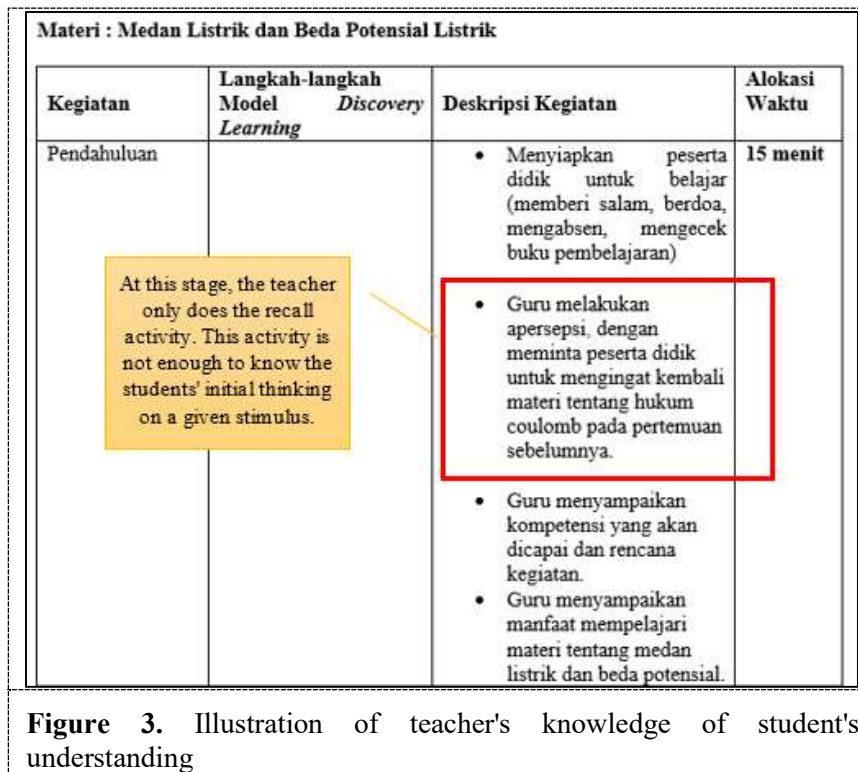


Figure 3. Illustration of teacher's knowledge of student's understanding

The teacher's knowledge of the curriculum that was illustrated in the lesson plan also did not show better results. Although the teacher has mastered the structure of the material in the school curriculum, but the weakness of the teacher lies in the inability to formulate a derivative of learning indicators and learning objectives based on the basic competencies that exist in the school curriculum. An example of findings was shown in Figure 4.

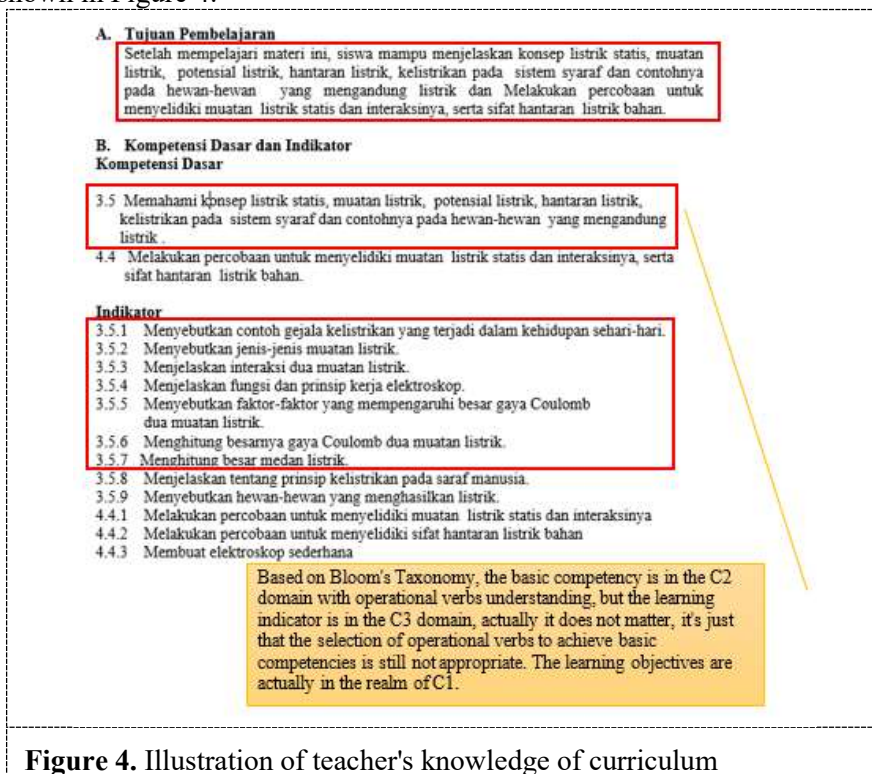


Figure 4. Illustration of teacher's knowledge of curriculum

Research findings indicated that teachers within sufficient subject matter knowledge and other general pedagogical knowledge indicators tend to lack PCK, specifically knowledge about instructional strategies. Therefore, they usually use inappropriate teaching and learning strategies [45]. Also, knowledge about relevant developmental and cognitive research, including learning theories, learning media especially multimedia, and interactions with students, is given as other factors [46].

3.3.2 The case of science courses within the STEM education in lesson plan

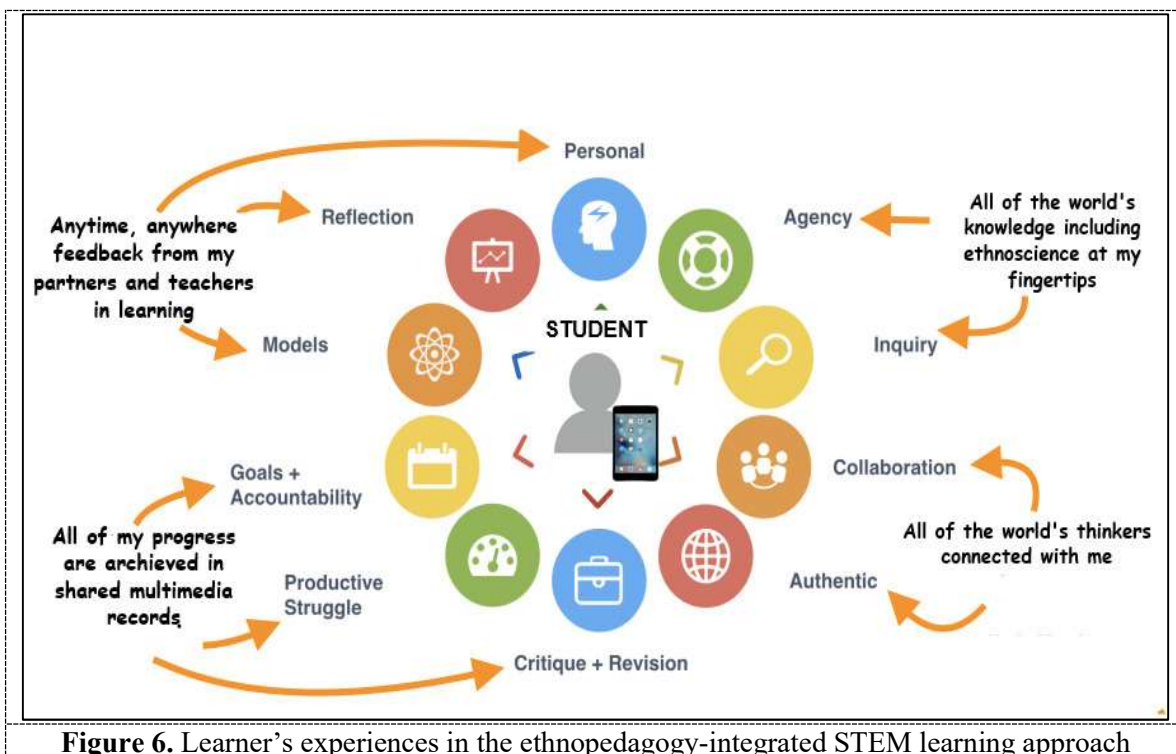
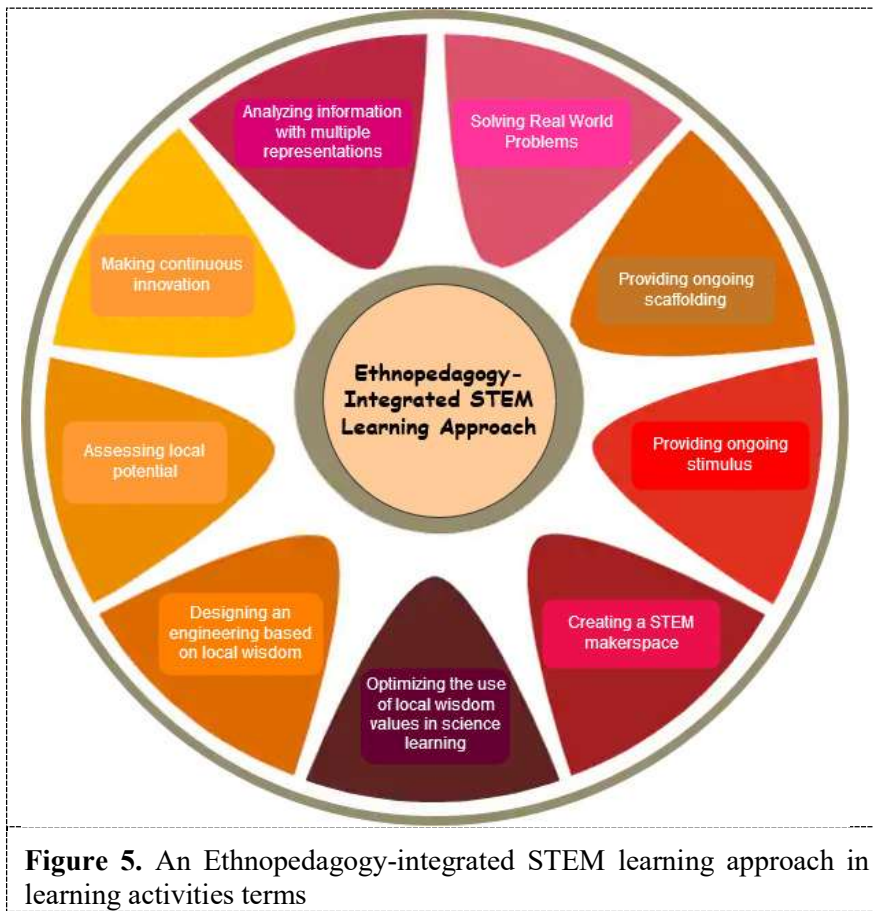
Research findings indicated that teachers tend to use inappropriate teaching and learning strategies to integrate STEM in learning. Broadly speaking, the content of learning material has led to STEM (e.g. students design a simple electrical circuit to identify charge), but the sequential learning designed by the teacher in the lesson plan has not yet shown the integration of STEM. Sequential is only formulated based on a scientific approach. So, we can conclude that the teacher does not have a pattern in teaching science based on the STEM approach. The lesson plan developed by the teacher is not yet a sample lesson plan for science courses within the STEM education.

3.3.3 The case of the ethnopedagogy-STEM integration in lesson plan

In the lesson plan that we identified, we did not find any ethnopedagogy elements integrated into learning. Though many learning products produced by students who take advantage of the potential or local wisdom in their area. There is also no sequential learning in the lesson plan developed by the teacher that shows learning activities that lead to the development of ethnopedagogy. So, the lesson plan developed by the teacher is still not specific, so the design and learning scenario was not described in the stages. That is, teachers also did not have a pattern in integrating the concept of ethnopedagogy in learning.

3.4. A hypothetical model of prospective ethnopedagogy-integrated STEM learning approach Analysis

Finally, we designed a hypothetical model in the form of an Ethnopedagogy-Integrated STEM Learning Approach. This learning approach is designed to give teachers a pattern reference in applying a learning that is based on the integrated ethnopedagogy concept of STEM. This hypothetical model was designed based on several weaknesses obtained from the results of survey analysis and document analysis. Design suggestions from survey results and literature studies were embedded in the design and development step. The design step was referred to determine the learning approach, designing strategy framework, mapping a sequential strategy based on theoretical rationality, and learning and work environmental [47-48]. We have already designed and validated an Inquiry-based STEM Learning Strategy as a Powerful Alternative Solution to Facilitate Gift Students Facing 21st Century Challenging [13] In this paper, we incorporate the concept of ethnopedagogy into the general sequential learning of the strategy and produce a new approach that was illustrated in Figure 5 and 6.



4. Conclusion

The survey results showed that the teacher had utilized several ethno potentials that have developed in the community, which could be elaborated in science classes using the STEM learning approach. The results of the document analysis have resulted in the finding that most teachers did not have a pattern yet for applying STEM learning that was related to local wisdom in their society. The hypothetical model of the learning approach could be a powerful alternative solution to serve all the skills needed in the future. The hypothetical model proposed should be implemented in the future research.

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