Student Problems in EthnoSTEM PjBL Based Science Learning

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Abstract. EthnoSTEM-PjBL learning involves project-based learning that is integrated with four STEM fields based on local culture. Etno-STEM PjBL aims to develop stu-dents' skills according to the demands of the 21st century. This research aims to analyze student problems in science learning based on EtnoSTEM-PjBL. The method used in this research is a mixed method. The instruments used in the re-search were questionnaires and interviews. The subjects of this research were middle school students in class VIII of SMP in Karanganyar. The results of the research show that students experience several problems in Etno-STEM PjBL based science learning. These problems include: a) As many as 43.3% of stu-dents find it difficult to determine basic questions related to cases related to local culture/wisdom raised in learning; b) As many as 73.4% of students found it dif-ficult to design projects; c) As many as 46.7% of students found it difficult to prepare a project schedule; d) As many as 41.6% of students found it difficult to monitor and evaluate projects; e) As many as 56.7% of students found it difficult to reflect on the products they had made; f)) As

many as 51.3% of students found it difficult to communicate products both written and verbally. Based on the research results, it can be concluded that the

Keywords: Student problems, EtnoSTEM-PjBL, science learning.

1 Introduction

The rapid development of technology and information in the 21st century has had a significant impact on various aspects of life, including education. The need for quality education to address these evolving times can be achieved through innovations in learning, encompassing both the teacher and the learners [1], [2]. The shift from teacher-centered learning to student-centered learning [3] reflects the demands of 21st-century education, which require students to possess skills in creative thinking, critical thinking, collaboration, communication [4], information management, effective technology use, career and life skills, as well as cultural awareness [5].

One of the efforts to cultivate cultural awareness among students is through multicultural-based education [6]. According to [7], multicultural learning is suitable for addressing 21st-century challenges, the ethnoSTEM approach emerges as a multicultural-based science education. EthnoSTEM integrates cultural elements with

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the four STEM components: science, technology, engineering, and mathematics [8]. Using ethnoSTEM for instruction aims to shape students into independent problem solvers with logical thinking skills.

The EthnoSTEM approach can be combined with student-centered learning models, one of which is the Project Based Learning (PjBL) model [9]. PjBL is a constructivist learning approach that requires students to construct their own experiences [10]. It involves problem-solving by a group of students, culminating in the creation of a product [11]. EthnoSTEM-PjBL education involves project-based learning integrated with the four STEM domains based on local culture to develop critical, creative, innovative, and collaborative thinking skills [12], [13].

However, on-field observations reveal challenges in implementing ethnoSTEM-PjBL-based science education. [14] state that teachers still struggle with designing lesson plans, the ethnoSTEM teaching process, and assessment of ethnoSTEM learning. [15] also report problems in STEM teaching from the teacher's perspective, including misconceptions about local wisdom and the failure to integrate it into their instruction. This study differs from previous research as prior studies primarily focused on analyzing the challenges of implementing ethnoSTEM-PjBL-based science education from the teacher's standpoint. This study, however, analyzes the challenges from the perspective of students.

By examining these issues, predominant challenges at each learning stage can be identified. A more profound exploration of the primary causes of student-related challenges is required to facilitate improvements in the learning process. Challenges in education can hinder the learning process and impact learning outcomes negatively. Educators must continuously strive to refine and improve their instructional methods to create effective and efficient learning environments.

2 Method

This study employed a mixed methods research design. The model used is concurrent mixed method with a concurrent embedded strategy, which is research that combines quantitative data (primary method) and qualitative data (secondary method) at one time. Quantitative methods play the role of obtaining measurable quantitative data, while qualitative methods play the role of proving, deepening and expanding the quantitative data that has been obtained at the initial stage. The research population was class VIII junior high school students at SMP N 4 Karanganyar, Central Java Province, Indonesia. Sampling used purposive sampling technique. The criteria used are students who have received vibration and wave material using the EthnoSTEM-PJBl learning model. The number of samples who filled out the questionnaire was 30 students, but the number of samples used for interviews was 6 students. The research instrument used was a closed questionnaire using a Likert scale and interview guide. The instrument validation technique used was the Gregory test with two science education experts. After validation was carried out by the two judges, it was then analyzed using the Gregory formula, which is as follows:

$$V_c = \frac{D}{A + B + C + D}$$

Vc: content validity
A: Both judges disagree
B: Judge 1 agrees, judge 2 disagrees
C: Judges 1 disagrees, judges 2 agree
D: Both judges agree

Based on assessment calculations using the Gregory formula, the interview content validity value was 0.96 (very valid), and the questionnaire content validity value was 1 (very valid). The data analysis technique from respondents' answers on the questionnaire sheet is quantitative data which will be processed using Microsoft Excel. Data processing is carried out in four stages, namely: a). Scoring (giving scores to the statement items contained in the questionnaire. Each statement is given a score based on a Likert Scale, b) Tabulating (systematically arranging each respondent's answers into tables and diagrams to make data processing easier. Questionnaire results are calculated using percentages, namely dividing the data results with a frequency distribution whose formula is as follows:

$$P = \frac{f}{n} \times 100\%$$

Information:
P= percentage
F= frequency
n= number of samples

c) Data display (researchers present data in the form of narrative text, d) Drawing conclusions by reviewing research results with existing theories. Qualitative data analysis techniques in the form of interview data use the theory of [16]. The quantitative and qualitative data that have been processed are then analyzed again simultaneously using source triangulation, namely the results of quantitative data analysis compared to the results of qualitative data analysis.

3 Result and Discussion

The issues regarding ethnoSTEM-PjBL-based science education, as observed from the responses of eighth-grade junior high school students in Karanganyar through questionnaires, interviews, and observations, are associated with the implementation of ethnoSTEM in the context of vibration, waves, and sound. Several problems experienced by the students are delineated as follows:

3.1 Students struggled in formulating fundamental questions related to cases intertwined with the culture/local wisdom incorporated into the learning.

The local wisdom addressed in this study was Javanese "Kendang." At the beginning of the learning process, a scenario concerning the disappearance of a Kendang belonging to a music group was presented. Students were tasked with assisting in

crafting a replacement Kendang to ensure the continuity of the music performance. Students were required to formulate fundamental questions pertaining to the presented case, involving the formulation of research questions and hypotheses based on the research questions. The expected research questions included: a) What are the requirements for a Kendang to function as a replacement for the lost Kendang? b) How can one determine whether a Kendang can serve as a suitable replacement? c) What factors influence the sound produced by a Kendang? The expected hypotheses encompassed: a) The sound produced by the replacement Kendang is identical to that of the original Kendang. b) The determination of a suitable replacement Kendang can be achieved by measuring its frequency to match the original Kendang. c) Factors such as resonator length, thickness, and membrane type. The questionnaire results data revealed that 43,3% of the students encountered difficulties in formulating fundamental questions related to the presented case. The results of the interview stated that these difficulties were because students were not used to learning related to cases in everyday life. Students are also not familiar with the activities of analyzing a problem, determining basic questions, formulating problems and making hypotheses.

The stage of formulating fundamental questions serves the purpose of creating a problem framework. In line with [17], who noted that constructing a problem framework can be challenging for students unaccustomed to this type of activity, several key approaches to support this stage, as outlined by [18], are as follows: a) Teachers provide examples of open-ended problems and then prompt students to generate their own questions. b) Encouraging students to restate the problem and consider various perspectives. c) Teachers offer scaffolding to students in formulating questions about the problem. d) Assisting students in developing a personal connection with the problem to position them. Another approach, as proposed by [19], involves teachers providing scaffolding by offering a set of questions as an organizational tool to aid students in generating questions about the problem.

3.2 **Students found it difficult in designing project.**

The questionnaire results data shows around 73,4% students encountered difficulties in project design, which can be examined as follows: a) The students faced challenges in reconstructing the societal science aspects of Javanese Kendang into scientific concepts. Consequently, they had difficulty in identifying scientific and mathematical concepts to serve as the foundation for project implementation. Kendang is a percussion-based musical instrument that requires a resonator to amplify the sound produced by the struck or played membrane [20]. The scientific concepts students needed to understand included the components and characteristics of Kendang, the relationships among its components, the connection between Kendang components and the resulting sound, the types of Javanese Kendang and their characteristics, and the factors affecting the sound produced when striking Kendang. b) The students encountered challenges in selecting the tools and materials required to create a replacement Kendang. c) The students experienced difficulties in designing the replacement Kendang product. The STEM aspects that permeate this stage encompass science, technology, engineering, and mathematics. In the realm of science, students needed to grasp factual, conceptual, procedural, and metacognitive knowledge. Factual knowledge involves observing the components of the Kendang musical

instrument and their characteristics. Conceptual knowledge includes understanding concepts related to vibration, waves, and sound, as well as their applications in everyday life. Procedural knowledge covers the steps for creating a simple paralon Kendang. Metacognitive knowledge entails determining the component materials for crafting the Kendang based on specific needs. In terms of technology, the students had to produce a paralon Kendang musical instrument by applying concepts related to vibration and sound to produce harmonious sounds. The engineering aspect involved designing a basic paralon Kendang using provided materials. Mathematics played a role in calculating the period and the number of vibrations produced during the experimentation with the simple paralon Kendang. The results of interviews with students stated that these difficulties were because students were not yet familiar with project design activities. Students have difficulty finding the concepts needed to design projects independently.

This is in line with [21], which indicated that some students encountered difficulties in project design. Students were not accustomed to project-based worksheets, which required them to independently devise steps for project construction and find solutions to the given problems. Students were more accustomed to dealing with theoretical problems and, as a result, often relied on teacher assistance in project planning and execution. [22], [23] also stated that the biggest difficulty for students in STEM learning is designing products. Students need to have a scientific attitude to be successful in these design activities [23].

To address these issues, teachers can provide scaffolding to students. This scaffolding may involve guiding students during the initial stages of the learning process. The guidance can take the form of instructions, motivation, warnings, breaking down the problem into planning and problem-solving steps. This scaffolding should be gradually reduced to enable students to learn independently and take on greater responsibility [24]. Project design as an investigative stage will provide students with valuable experiences, enabling them to discover learning concepts independently [24].

3.3 **Students found it difficult to design a project schedule.**

The scheduling of the project aims to provide a time reference for the implementation of each project stage to ensure a smooth and timely progress. The activities involved in project scheduling include: Designing product 1, Crafting product 1 based on the design, Testing product 1, Designing product 2, Crafting product 2 based on the design, Testing product 2, Creating an experimental report, Presenting the final product

The questionnaire results data shows Approximately 46,7% of the students encountered difficulties in developing project completion schedules. The interview results also stated that students found it difficult to determine the right schedule independently because they were not used to it and because of the lack of cooperation in groups. This aligns with the findings of [21], which indicated that students were not accustomed to effectively designing project schedules. This lack of familiarity stemmed from students being more inclined to solving problems theoretically, with minimal experience in the practical aspect of designing (engineering). Students experience frustration due to limited interaction with other members [22], [25]

3.4 Students faced difficulties in creating the product, conducting product testing, and analyzing the test results.

The questionnaire results data shows approximately 41,6% of the students encountered challenges in crafting a replacement Kendang using alternative materials. A deep understanding of the local wisdom incorporated, specifically the authentic Kendang and its components, was essential for the successful execution of the project. After crafting the Kendang (product 1), students were required to conduct tests to evaluate the product's performance as a replacement for the lost Kendang. This testing involved measuring the frequency of the simple paralon Kendang. Subsequently, students were tasked with analyzing the experimental results, including identifying the type of membrane material used, membrane thickness, resonator length, strike sound frequency, as well as calculating the period and the number of vibrations. The research findings revealed that the students encountered difficulties in testing the Kendang's performance, and another student had challenges in analyzing the experimental results. Similar challenges were also noted by [26] that some students experienced difficulties in comprehending experiments and gathering information [27]. The results of the interviews also showed that students found it difficult to make products, test them and analyze the frequency of the drums that had been made. This is because students do not understand science concepts from the start.

Asserted that students' ability to examine experimental results remained insufficient due to their low problem-solving skills [28]. With their limited problem-solving capabilities, students struggled to identify relationships between variables and encountered difficulties in generating scientific ideas related to a concept and a range of solutions to specific problems.

3.5 Students found it difficult to reflect on the products they had created.

The purpose of product reflection was to determine whether the product met the requirements as a replacement Kendang. Product reflection was carried out by considering several observed indicators: a) Components affecting the frequency of the Kendang strike sound experiment. b) Reasons if the produced product did not meet the requirements. c) Plans for altering components. d) Objectives for the next product. If product 1 did not meet the requirements as a replacement Kendang, students were asked to revise the product based on guidance and input from the teacher and other group members, taking into account the strengths and weaknesses of product 1. Subsequently, students were required to select the best product and provide reasons for their choice. Based on the questionnaire results data. it was revealed that 56,7% of the students encountered difficulties in reflecting on the products. The results of the interviews also showed that students found it difficult to assess their own products and those of other group members. This is because students are not yet accustomed to evaluating activities in learning. In line with the research results of [29] which stated that students' evaluation abilities were still relatively low. This is because this ability is very difficult for students. Evaluating requires a lot of knowledge, experience, and understanding

3.6 Students encountered difficulties in communicating their work/products, both orally and in writing.

The products created by each group were communicated through oral presentations and written project completion reports. Engaging in product presentations could foster student independence and enhance their ability to evaluate their project experiences [30] Students' involvement in written communication helps them convey and convey knowledge consistently and accurately, so that they can avoid mistakes in abstracting information.However, the questionnare result showed that approximately 51,3% of the students faced challenges in composing experiment reports. Based on the results of the interview, it was also stated that students still found it difficult to verbally communicate the products they had made. This is also in line with [31] that students' communication skills are still low so they need effective encouragement in the form of using appropriate learning models.

4 Conclusion

Based on the explanation above, it can be concluded that there are several student problems in EtnoSTEM PjBL-based science learning. These problems include: difficulties in formulating fundamental questions related to cases intertwined with the culture/local wisdom incorporated into the learning,difficult in designing project, difficult to design a project schedule, difficulties in creating the product, conducting product testing, and analyzing the test results. difficult to reflect on the products they had created, and difficulties in communicating their work/products, both orally and in writing. The most dominant problem is difficulties in designing projects.

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