Is integrating earth and space sciences (ESS) with art contexts necessary?

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Abstract. The study aims to obtain facts related to the process of implementing Physics learning on Earth and Space Sciences (ESS) subject in Bandung area. This study has been conducted to 125 twelfth graders and 3 teachers from three high schools in Bandung area through a survey method with questionnaire fulfilment. The results state that the student interest, self-attraction and agreement of integrating ESS subject with other subjects are positively response. On the other hand, the learning should be improved. Physics learning requires the involvement of students in finding their own knowledge through interaction with their environment. However, students stated that the perceived obstacle in ESS learning was the lack of involvement of students in learning. In conclusion, ESS is important to integrate with art context for developing several aspects. Furthermore, ESS developing process is needed to help teachers bring their classes in a more interesting, effective and innovative way.

1. Introduction

Earth and Space Sciences (ESS) are integration and synthesis of physics, biology, chemistry, oceanography, meteorology, geophysics, geology, and astronomy [1, 2]. This shows that to study ESS, several disciplines are needed to produce meaningful and comprehensive learning. Besides, the implementation of learning should be supported by the learning process that supports the integration.

To meet these demands, it is necessary to design models that can integrate and accommodate the needs of ESS learning. One alternative solution offered is through PjBL-STEAM. Project-based learning is an innovative approach to learning, involving learners through inquiry, as well as work collaboratively to research and create projects that reflect their knowledge [3]. Project-based learning is more appropriate in interdisciplinary learning because it naturally involves many subject courses [4, 5]. More broadly, the integration of ESS subject can also be accommodated with the STEAM approach. STEAM is a development of learning model approaches from previous model approaches, namely STEM by adding aspects of art. It is a contextual curriculum where learning material is connected to support each other as it connects science, technology, engineering, mathematics and art in the real world [6-8].

So, based on the description above, researcher intends to conduct a survey of teachers and student’s readiness regarding the implementation of ESS learning and the integration of various fields of study in ESS subject.
2. Methods

2.1 Participant
The sample of this study were 125 high school students and 3 teachers from 3 high schools in Bandung City and its surroundings with various background.

2.2 Instrument
The instrument used in this study was a questionnaire with 4 questions for students and 4 questions for teachers related to ESS learning. The questionnaires were distributed from 18 August 2018 to 3 September 2018.

2.3 Research Design
Research conducted is a survey research. The purpose of this study was to obtain facts related to the process of implementing Physics learning on ESS subject in the city of Bandung.

2.4 Data Analysis
Data analysis used in this study was descriptive statistics, so that descriptive data were processed with appropriate statistics.

3. Results and Discussion
After the student questionnaire was distributed, research data was obtained related to ESS learning as follows,

![HS students' responses to question on interest in learning ESS subjects at school.](image1)

Figure 1. Student questionnaire results related to the question "Are you interested in learning ESS subjects at school?".

![HS students' responses to question on interest in ESS subject.](image2)

Figure 2. Student questionnaire results related to the question "Is ESS subject interesting?".

Based on the results shown above, it can be seen that 44% of high school students were interested in studying ESS, and the ESS subject taught was interesting according to 58% of students. It could be the strengthening point to implement the PjBL-STEAM knowing that the student can easily accept the learning process because of their interest on ESS subject.
Unfortunately, this study found that the teachers’ understanding on ESS subject is still in low to average level, as seen in the chart below.

![Figure 3](image-url)  
**Figure 3.** The results of the teacher questionnaire related to the question "How is your understanding of ESS subject?".

Besides, as many as 20.8% of high school students stated that the perceived obstacles in ESS learning were the lack of involvement of students in learning.

![Figure 4](image-url)  
**Figure 4.** The results of the student questionnaire related to the question "What are the perceived obstacles in studying ESS?".

However, we also found the opportunity to develop the model of PjBL-STEAM. The 58% high school students have stated the agreement regarding the integration of ESS learning with another subject, as seen below.

![Figure 5](image-url)  
**Figure 5.** Student questionnaire results related to the question "What do you think if ESS lessons are associated with art, language, social studies, mathematics or other lessons?".
Besides, regarding to the using of learning model, we found that the teacher has used various of learning models, such as Discovery Learning, Problem Based Learning, and Problem-Solving Learning.

![Figure 6](image1.png)

**Figure 6.** The results of the teacher questionnaire related to the question "What learning model is used by the teacher in teaching ESS subject in the classroom?".

Project-based learning and problem-based learning require changes in the role of the teacher from being a 'source of knowledge' (teacher centered) to being a trainer and facilitator to gain knowledge [5,9,10]. Besides, the lack of the teachers experience of project work could be the obstacle to implement the project-based learning itself [11]. Despite the teacher still encounters obstacles when learning related to the model used, but this result shows a good point that the teachers have tried to leave the teacher centered model, such as direct instruction. Still, it is demanding the creativity and readiness of teachers in the implementation of the learning process. Because in this learning process, teachers are required to be able to instil the concept of physics, especially in the subject matter of ESS, by facilitating and providing direct learning experiences to students.

Physics learning requires the involvement of students in finding their own knowledge through specific practice. In the process of implementing learning like this, the teacher's task is not only to teach how to perform the specifics task, but also teach how to create a solution to a problem which has not been solved in the past [12].

As explained earlier, ESS is a science that requires several other disciplines that aim to produce meaningful and comprehensive learning. However, based on the teacher's questionnaire, it can be seen that there is no awareness of high school teachers in linking ESS with other subject, which is indicated by a percentage of 66.7% teachers have not integrated ESS subject with other subjects yet.

![Figure 7](image2.png)

**Figure 7.** The results of the teacher questionnaire related to the question "Have you ever integrated ESS subject with other subject such as mathematics, art, etc.?".
This result presents the threat of the development of PjBL-STEAM model. More broadly, the integration of ESS subject by using PjBL-STEAM, need the teachers’ understanding of the STEAM itself. STEAM (Science, Technology, Engineering, Art and Mathematics) is a development of learning model approaches from previous model approaches, namely STEM (Science, Technology, Engineering and Mathematics) by adding aspects of art [10]. The addition of art to science can make learning more effective and innovative [13]. STEAM's integration education (Science, Technology, Engineering, Arts and Mathematics) is an integrated learning between science, technology, engineering, art and mathematics. Through the STEAM approach, science and technology are understood as the basis of what the world must advance, be analyzed and developed through engineering and art, with the knowledge that everything is based on mathematical elements [14].

The following is a pyramid that shows the relationship between five different disciplines that are integrated into STEAM.

![Figure 8. STEAM pyramid scheme [14].](image)

With STEAM, students not only strengthen learning from various disciplines, but also students can explore and connect between art, music, science and others [7,13]. The learning discourse with the STEAM approach can begin to be applied. But unfortunately, this is different from high school teachers who know that 66.7% of teachers do not know the learning using the STEM / STEAM approach.

![Figure 9. The results of the teacher questionnaire related to the question “Do you know about learning using the STEM / STEAM approach?”](image)
4. Conclusion
Based on this research, ESS is important to integrate with art context through STEAM approach for developing several aspects. The addition of art to science can make learning more effective and innovative. Moreover, based on the results of the questionnaire, the integration of ESS subject with other subjects was approved by high school students. But unfortunately, teachers have not integrated ESS subject with another subject. Besides, the teachers haven’t known yet about the STEM/STEAM approaches. In subsequent research, it is recommended to begin developing research related to the model of PjBL-STEAM to help teachers integrate ESS subject with other fields of study in a more interesting, effective and innovative way.

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