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Research Article

STEM-Blended Learning Regarding Earthquake Disaster: Prospective Teachers Perception

Didit Ardianto[1]*, Bibin Rubini[1], Indarini Dwi Pursitasari[1], Indriyani Rachman[1,2]

[1]Department of Natural Science Education, School of Postgraduate Studies, Universitas Pakuan, Indonesia 16143
[2]Department of Environmental System, Graduate School of Environmental Engineering, The University of Kitakyushu, Kitakyushu, Japan, 802-85772
*Corresponding author, e-mail: diditardianto@unpak.ac.id

Abstract

This study aims to determine student teacher perceptions of the implementation of STEM-Blended learning. The subjects involved in this study consisted of 25 4th semester students in the elementary school teacher program. The instruments used include closed questionnaires and open questionnaires. The results showed that students gave a positive attitude towards scientific and engineering practices in the lecture process. In addition, they are also very motivated to create a prototype design that integrates STEM

Keywords: STEM education; blended learning; environmental disaster

1. Introduction

The Indonesian Central Statistics Agency predicts that Indonesia will experience a demographic bonus in 2030. However, this situation does not necessarily increase economic growth because workers who enter the labour market are unskilled (Badan Pusat Statistik, 2012). To become a country with economic growth ranked seventh globally by 2030, 113.7 million skilled workers are needed. Data from the Central Statistics Agency show that in 2015 Indonesia only had 57 million skilled workers, meaning that an additional 3.8 million additional skilled workers are needed each year. Statistics Indonesia also states that the main types of employment in Indonesia are still dominated by the service sector (47.65%), agriculture (31.86%) and manufacturing (20.49%) (Badan Pusat Statistik, 2012). These data provide evidence of the low number of human resources occupying engineering/engineering jobs. Therefore, Indonesia needs to accelerate in preparing adequate human resources both in quality and quantity. Preparation of qualified resources can be done in various ways, including through education.

Science, Technology, Engineering, and Mathematics (STEM) education is believed to improve the quality of human resources. STEM education is emerging as a global movement to bridge the gap between the need and availability of skills required for economic development in the 21st Century (Firman, 2015). STEM education emphasizes that individuals can see the relationship between science, technology, engineering, and mathematics in natural phenomena. STEM education does not mean only the functional strengthening of education in STEM fields separately. Instead, it develops an educational approach that integrates science, technology, engineering, and mathematics by solving real problems in everyday life and professional life (National STEM Education Center, 2014).

According to several studies, the STEM approach has improved thinking skills, scientific literacy, and technological literacy (Afriana et al. 2016; Wagner et al. 2015). STEM education is an opportunity to develop competencies in areas of great interest. The engineering discipline is a STEM integrator, which presents problem-based activities. Several studies have shown that STEM education positively impacts student interest in STEM (Becker & Park, 2011). In addition, Stohlmann, Moore, & Roehrig (2012) stated that STEM education provides a real student learning experience to be more meaningful.

In the era of the industrial revolution 4.0 and the current pandemic, education through information technology is necessary. Learning patterns should be limited by classrooms and face-to- face activities but can use technology-based learning with unlimited reach, beyond classroom boundaries, such as Blended Learning. Blended learning is a learning model that can face challenges in the current era. Blended learning is a learning pattern in education that combines face-to-face learning methods with online learning activities (Voos, 2003; Garrison & Kanuka. 2011; Graham, 2004). Blended Learning provides high access and flexibility for students because learning is not limited by space ("learning is not always done in class") and time ("students can learn at any time the material provided) (Boyle et al. 2003).

The integration of Blended Learning and the STEM approach can solve time constraints in training students' 21st-century skills, especially in the industrial revolution 4.0. This is because learning that combines face-to-face and online methods has a positive contribution to improving student performance (Boyle et al. 2003; Lim & Morris, 2009; O'Toole & Absalom, 2003; Tam, 2000) and creating a flexible learning environment in encouraging students to learn independently, reflect on knowledge and research (Tam, 2000), and can facilitate review and chat about learning (Osguthorpe & Graham, 2003). Several previous studies have reported that STEM learning can improve the performance of students with low achievement and can reduce student achievement gaps (Brophy et al. 2008), increase effectiveness, build meaningful learning and influence students' attitudes in choosing a career in the future (NRC, 2012); increase students' understanding of STEM integration and students' imagination power in project-based activities (Wagner et al. 2015), and can improve students' scientific (Kozalka et al. 2007). The STEM-PjBL approach can be integrated into Hybrid Learning. Therefore, this study aims to determine the impact of implementing the STEM-Blended learning Model on student-teacher perceptions.

2. Methods

This study consisted of 25 elementary school preservice teachers for the 4th semester taking Earth and Space Science courses. Students get courses such as Basic Physics, Basic Biology, Basic Chemistry, and Basic Mathematics. The instruments used included closed and open questionnaires and researchers' logbooks. The student questionnaire aims to determine the perspective of STEM-Blended Learning students. The focus of the questions in the questionnaire explores specific activities carried out by students during the lecture process and the contribution of these activities in facilitating their understanding of the concepts being learned. The open questionnaire aims to look for students' perceptions and experiences about the lectures they are doing using the lecture model that is designed. The focus questionnaire includes what they like (dislike) about the model, the learning activities, and how this new learning compares to regular geoscience learning. Questionnaires are distributed online using google forms facilities after students have completed a series of lecture activities. The STEM-Blended Learning model is implemented on earthquakes with the activity stages shown in Table 1.

Table 1. Learning activity

Day/ Mode	Learning Activity
1 (Online Learning)	1. Students watch videos about earthquake phenomena that have occurred in Indonesia. 2. Students identify problems related to the video.
2 (Face to Face)	1. Students conduct experiments on the origin of earthquakes

Day/ Mode	Learning Activity
	2. Students discuss the location of the earthquake epicentre in groups
3 (Online Learning)	1. Students in groups design / draw the concept of earthquake-resistant buildings
4 (Face to Face)	1. Students test the earthquake-resistant buildings that have been designed 2. Students analyze the results of the experiment and evaluate the building 3. Students communicate the test results in front of the class. 4. Students are asked to make conclusions about the learning that has been done.

3. Result and Discussion

STEM learning requires students to connect science and engineering. In addition, students are also challenged to create authentic engineering as a product of science learning through project activities that integrate science, engineering, technology, and mathematics (Bybee, 2013). STEM-based science education demands a shift in the mode of the learning process from conventional teacher-centred modes to student-centred learning modes that rely on student activity, hands-on, and collaboration. STEM-based science learning needs to be implemented in project-based learning units. Students are challenged critically, creatively, and innovatively to solve real problems and produce technological products, which involve collaborative group (team) activities. STEM-based science learning in the classroom is designed to allow students to apply academic knowledge in the real world. STEM-Blended learning is considered appropriate as a solution to prepare students in the 21st century. STEM-Blended Learning has the following characteristics; 1) learning is carried out in 2 modes, namely face-to-face learning and online learning, 2) facilitating students to inquiry and applying engineering principles, 3) providing opportunities for students to collaborate with peers, 4) in addition to providing opportunities for students to communicate ideas or ideas creatively and apply STEM disciplines to solve a problem.

Students' perspectives and experiences using the STEM-Blended Learning model were obtained using a questionnaire. Student responses to specific activities in the lecture process were analyzed quantitatively. Student perspectives on the implementation of STEM-Blended learning are shown in table 2. In general, students positively respond to activities in the learning process using STEM-Blended knowledge. However, according to students, two actions are not helpful during the lecture process. The first aspect is the absence of lecturer guidance/explanation during experimental activities and product design. 39% of students stated that these activities helped in the learning process. This shows that the role of lecturers in guiding students during practical exercises and designing products is essential. 91% of students stated that experimental activities were beneficial for them in the learning lecture material. Likewise, with product designing activities, this activity is considered very helpful for students in understanding the application of technology used to solve geoscience problems in the surrounding environment.

Table 2. Students' perspectives on specific activities during the lecture process

No	Did the following activities help you during the lecture process?	N	Mean	Standard Deviation	Help/Very Helpful (%)
1	Conduct experiments in groups	23	4,3	1,00	91,3
2	Designing products/prototypes in groups	23	4,2	0,88	86,9

No	Did the following activities help you during the lecture process?	N	Mean	Standard Deviation	Help/Very Helpful (%)
3	Work on worksheets while learning	23	4,0	1,02	78,2
4	The lecturer did not explain anything when experimenting and designing the product	23	2,3	1,37	39,1
5	Read the material and do assignments online	23	3,5	0,93	52,1
6	Doing tasks independently	23	3,7	1,09	65,2

The second activity of concern is reading material and doing assignments online. Students' views about this activity are still pros/cons. As many as 52,1% stated that this activity did not help them learn the lecture content. It can be predicted that students are less accustomed to independent learning and depend on lecturers' face-to-face explanations. Although more than half of students responded negatively, 48% of students stated that this activity tends to be very helpful in the learning process. Researchers believe that students who respond positively are accustomed to learning independently and not depending on lecturers' explanations. Although student responses are still pros and cons, researchers consider this activity quite important. Therefore, the presentation of material and assignments online needs to be improved (for example, the production of the material is more interactive and communicative) so that students who are not accustomed to independent learning become motivated.

As many as 78% of students thought working on worksheets helped them learn the material content. This shows that several worksheets during the lecture process are not a burden for students. On the other hand, having assignments on the worksheet helps students build concepts independently. In addition, independent assignments also get positive responses from students. 68% of students stated that independent assignments help them study independently outside of class hours. So this activity helps strengthen students' understanding of the material studied in class. These findings indicate that, in general, the activities designed in STEM-Blended Learning are constructive for students in learning lesson content. Experimental activities, product design, discussion, and assignments are appropriate means of facilitating student learning in meaningful ways. The activities made students active and lecturers as facilitators in the learning process.

Students also respond to the aspects they like the most in the lecture process. The data obtained show that students react positively to factors in lectures. The element they wanted the most in the lecture process was when they designed the prototype of an earthquake-resistant building. The following are student comments that show why they like this activity.

- When making earthquake-resistant buildings, we can know what sturdy building construction should be like to build it. When making water purification technology, we can imitate if dirty water can be done one day by filtering it with a tool we create ourselves.
- It can make me more creative in experimenting with creating an earthquake-resistant house.
- Prototyping is fun. Meanwhile, although it is quite difficult to choose the appropriate materials to make water clear when making water purification technology, it is quite fun.
- Because this material is more related to everyday life events, it can help me understand and implement the anticipation and management of the disaster.
- Students also feel happy with the practical activities during the lecture process. The following is an example of student comments stating that they are satisfied with experimental activities during the lecture.
- The material is exciting and easy to understand because implementing the practice is fun.
- Because doing experiments makes you understand better

- It can make me more enthusiastic about learning because of the many teaching practices and a better understanding of the material.

The distributed questionnaire also revealed aspects that students disliked the most during the lecture process. The element they don't like in the learning process is that the material studied is quite deep and complicated. In addition, there was a student who did not like practical activities. The student thought that practicum required a long time, and the materials were difficult to obtain, making the class dirty. In addition, the materials used are difficult to find. In addition, several students (2 people) stated that they did not like to learn ashtray concepts on earthquakes. Students were also asked for their views regarding learning methods that help them understand the material well. The majority of students stated that learning that began with face-to-face theory delivery and then continued with experimental activities was more meaningful than learning theory online, then experiment or experiment first, followed by approach. The following is an example of student opinion why they prefer to learn theoretically first face-to-face then followed by experimental activities.

- Learn the theory face-to-face first, then experiment. If we study the theory beforehand, we can determine what images will be done to conduct experiments at the next meeting.
- Learn theory face-to-face before conducting experiments because it will be easier to carry out investigations by understanding the theory first.
- So that when experimenting, you are no longer confused and have understood the stages.

Another aspect obtained from the student questionnaire is student opinions about the role of product design activities in supporting 21st-century competencies (creative thinking and collaboration). All students stated that designing product activities required thinking creatively and working together. This shows that product design activities that are integrated into the lecture process have a positive impact on 21st-century competence. Some of the students' views on the role of product design activities in training creative thinking and collaboration skills are as follows.

- This activity makes us think creatively and cooperate reasonably with friends.
- Yes, it allows me to think creatively and work with friends, communicate with friends, and respect the opinions of group friends so that products can get better results.
- Yes, the activities of designing a product in learning can make you think creatively and work together with friends
- During product design activities, we are required to think creatively and innovatively, and then if our thoughts are stuck, we can work together with friends as well as exchange ideas
- When designing products, group cohesiveness is needed

The last aspect revealed from the questionnaire related to student experiences about the convenience of learning when using the STEM-Blended Learning model. The data obtained from the questionnaire stated that the lecture process made it easy for them to learn earthquake material. The information obtained shows that students positively respond to activities designed in the lecture process using the STEM-Blended Learning model. Experimental activities, developing products and working on the worksheets in the lecture process help them construct knowledge independently. This finding is in line with the results of several previous studies, which also state that integrating technology and engineering in learning can improve learning and increase achievement in STEM disciplines (Han et al., 2014). Technological and engineering activities have been proven to develop STEM literacy and increase motivation. Besides, these activities can provide a real-world context for learning science and math concepts (Lou et al., 2018). Involving students in activities that are fun, direct, and related to everyday contexts can improve student attitudes towards STEM discipline, which in turn can encourage them to pursue STEM-based careers (Tseng et al., 2013). Engineering and experiment activity also trains problem-solving skills. It improves their understanding and communication skills related to the scientific and engineering aspects of the products made, in line with Wagner et al., who revealed that STEM-based learning could improve student problem-solving skills and scientific and engineering skills. Wagner et al. (2015) also showed that engineering integration makes it easier for students to see the connection between science and mathematics in solving real-world problems.

The finding also indicates that students do not like presenting too complicated and abstract material. In addition, some students gave negative responses to practical activities because these activities took a long time, materials were difficult to find and polluted the classroom. The findings are quite interesting. Namely, most students do not agree with presenting material online at the beginning of learning. They prefer knowledge that begins face-to-face and then continues with experimental activities. These findings are recommendations for improving the lecture model, especially related to the presentation of online materials/tasks.

Evidence also strengthens previous studies that state that STEM integration in learning can positively influence attitudes towards STEM (Tseng et al., 2013). The results of Guzey's research also show that engineering activities make students who have joined the STEM program become aware of the importance of STEM and tend to be interested in being involved in a problem-solving involving STEM discipline (Guzey et al. 2014). Students carry out the design process to solve problems and increase student interest in science and engineering activities. In addition, learning that begins with contextual issues can motivate students to solve these problems. These findings reinforce several previous studies that state that design activities positively impact interest and attitudes in scientific and engineering practice (Dinsmore et al. 2008) and can increase the motivation of students to be involved in the learning process (Lawanto et al. 2012).

STEM-Blended learning requires students to carry out scientific and engineering activities in each topic. These two activities train students in designing solutions or scientific investigations. Integration of engineering in learning can make students learn how to solve geoscience problems using science, technology, and mathematics, in line with Borgford-Parnell, Deibel, Atman (2010), which states that integrating engineering processes in the curriculum can improve problem-solving skills. They argue that engineering always involves working on complex and unstructured problems that are ambiguous and offer several solutions. If this activity is often used in the learning process, students will be trained in higher-order thinking, which is needed in their careers. STEM-Blended learning facilitates students to collaborate during the design process. Students are involved in defining problems, identifying problems and possible solutions, choosing the best solution by drawing conclusions, building and testing prototypes, and redesigning prototypes. Students work in a contextual environment to study science content during the design process. They also can be involved in the investigation process like a scientist and the design process like an engineer. They also can engage in collaboration, decision making, communication and design. These activities can be considered as part of scientific and engineering practice.

4. Conclusion

The STEM-Blended Learning model is an educational practice that integrates various integration patterns to develop the quality of human resources following the demands of 21st Century skills. This learning requires students to solve a complex problem by applying STEM knowledge. STEM-Blended Learning has characteristics, among others: education is carried out in two modes, namely face-to-face learning and online learning, facilitating students to inquire and apply engineering principles, providing opportunities for students to collaborate with peers, providing opportunities for students to communicate ideas or creative ideas and apply STEM disciplines to solve a problem. The implementation of STEM-Blended learning received a positive response from students. This shows that the model's performance positively influences student attitudes towards learning. In addition, scientific and engineering practices designed in the lecture process make them motivated and interested in the STEM issues that must be solved. This student perspective also provides evidence that integrating STEM in the lecture process positively facilitates students in constructing knowledge about STEM. The activities designed in learning are also very helpful for students in the lecture process. Students feel that practical exercises make learning more interesting and not boring. Design activities in education also provide quite a positive experience for students. Design activities designed to enable them to apply knowledge and technology in real-life situations to make learning more meaningful (meaningful learning).

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References

Afriana, J., Permanasari, A., Fitriani, A. 2016. Project based learning integrated to stem to enhance elementary school's students scientific literacy. Jurnal Pendidikan IPA Indonesia 5(2), 261–267.

Badan Pusat Statistik. 2012. Analisis Statistik Sosial Bonus Demografi dan Pertumbuhan Ekonomi. Jakarta: Badan Pusat Statistik.

Becker, K., Park, K. 2011. Effect of integrative approaches among science, technology, rekayasa, and mathematics (STEM) subjects on students' learning: A preliminary meta-analysis. Journal of STEM Education 12, 23-37.

Boyle, T., Bradley, C., Chalk, P., Jones, R., Pickard, P. 2003. Using blended learning to improve student success rates in learning to program. Journal of Educational Media 28(2–3), 165–178

Brophy, S., Klein, S., Portsmore, M., Rogers, C. 2008. Advancing rekayasa education in P-12 classroom. Journal of rekayasa Education 97(3), 369-387.

Bybee, R. W. 2013. The case for STEM education: Challenges and opportunity. Arlington, VI: National Science Teachers Association (NSTA) Press.

Dinsmore, D., Alexander, P., Loughlin, S. 2008. The impact of new learning environments in an rekayasa design course. Instructional Science, 36(5/6), 375–393.

Firman, H. 2015. Pendidikan STEM. In Prosiding Seminar Nasional Pendidikan IPA dan PKLH, Universitas Pakuan (pp. 1–9).

Graham, C. R. 2004. Blended learning systems: definition, current trends, and future directions. Dalam C. J. Bonk, & C. R. Graham (Penyunting), The handbook of blended learning: Global perspectives, local designs hal. 3–21. Zurich: Pfeiffer Publishing

Garrison, D., Kanuka, Heather. 2004. Blended Learning: Uncovering Its Transformative Potential in Higher Education. The Internet and Higher Education 7, 95-105.

Guzey, S. S., Moore, T. J., Harwell, M., Moreno, M. 2016. STEM integration in Middle School Life Science: student learning and attitudes. Journal of Science Education and Technology 25(4), 550-560.

Han, S., Capraro, R., Capraro, M. M. 2014. Differently : The impact of student factors. International Journal of Science and Mathematics Education.

Koszalka, T. A., Wu, Y., Davidson, B. 2007. Instructional design issues in a cross-institutional collaboration within a distributed rekayasa educational environment. World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education.

Lawanto, O., Santoso, H.B., Yang, L. 2012. Understanding the relationship between interest and expectancy for success in rekayasa design activity in grades 9–12. Journal of Educational Technology & Society 15(1), 152–161.

Lim, D. H., Morris, M. L. 2009. Learner and instructional factors influencing learning outcomes within a blended learning environment. Educational Technology & Society 12(4), 282–293.

Lou, S.-J., Chou, Y.-C., Shih, R.-C., Chung, C.-C. 2017. A study of creativity in CaC2 steamship-derived STEM project based learning. Eurasia Journal of Mathematics, Science and Technology Education 13(6), 2387–2404.

National Research Council. 2012. A Framework for K-12 science education: practices, crosscutting concepts, and core ideas. Washington, DC: The National Academies Press.

National STEM Education Center. 2014. STEM education network manual. Bangkok: The Institute for the Promotion of Teaching Science and Technology.

O'Toole, J. M., Absalom, D. J. 2003. The impact of blended learning on student outcomes: is there room on the horse for two?. Journal of Educational Media 28(2–3), 179–190.

Osguthorpe, T. R., Graham, R. C. 2003. Blended learning environments. Quarterly. Review of Distance Education 4(3), 227–233.

Tam, M. 2000. Constructivism, instructional design, and technology: implications for transforming distance learning. Educational Technology and Society 3(2), 50–60.

Tseng, K. H., Chang, C. C., Lou, S. J., Chen, W. P. 2013. Attitudes towards science, technology, rekayasa and mathematics (STEM) in a project-based learning (PjBL) environment. International Journal of Technology and Design Education: 23(1), 87–102.

Stohlmann, M. S., Moore, T. J., Cramer, K. 2013. Preservice elementary teachers' mathematical content knowledge from an integrated STEM modelling activity. Journal of Mathematical and Application 1(8), 18-31.

Voos, R. 2003. Blended learning: What is it and where might it take us?. Sloan-C View 2(1), 2–5.

Wagner, T. P., Mccormick, K., Martinez, D. M. 2015. Fostering STEM literacy through a tabletop wind turbine environmental science laboratory activity. Journal Environmental Study of Science.