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Challenge of Applying STEM Education to Improve Physics Problem Solving Skills in Islamic Boarding Schools

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Abstract: This study aims to examine the effect of the application of STEM education on students' problem-solving abilities at Islamic boarding schools in terms of educational background (santri-nonsantri and academic abilities). It is a pre-experimental research design using One Group Pretest-Postest Design. The population in this study is all physics education students at the Islamic University of Madura. The research sample is level 3 students, the determination of the sample is carried out using cluster random sampling technique. This research is a problem-solving ability test instrument in the form of description questions. Data collection is carried out by tests. Data analysis is carried out by two-way ANOVA test, N-Gain test, and effect size test. The results show the application of STEM education with influence significantly on the problem-solving ability of students in pesantren-based tertiary institutions and line with students' academic abilities. the higher the student's academic ability, the better the problem-solving ability. However, there is no relationship between the status of students and non-students. The challenges that must be solved in applying the STEM approach to Islamic boarding schools are difficulties in using mathematical procedures correctly and limited access to technology.

Keywords: STEM; Problem-solving skills; Islamic boarding school.

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Introduction

In the 21st century, students are required to have several competencies to compete in real life (Barak, 2017). One of the competencies that must be possessed by students is problem-solving skills. Problem-solving skills are a person's ability to solve problems that are being faced by utilizing their mathematics and science in solving problems, which is also a method of finding solutions through the stages of problem-solving (Griffin, Care, & McGaw, 2012; Hidayat et al., 2017). (Arini, Hartono, & Khumaedi, 2019) argues that a student who has problem-solving skills can develop his theory of a problem, test the theory, test the theory proposed by his friend and even not accept the theory and replace it with another theory if the theory is considered inconsistent and inconsistent with his thinking (Binkley et al., 2012). Based on this opinion, problem-solving skills can be defined as the ability to solve a problem by utilizing the knowledge it has. This problem-solving ability must be possessed by a student in preparation for facing challenges in the 21st century (Dewi, Kaniawati, & Suwarma, 2018).

Competency in problem-solving skills must be trained from an early age by applying them in the learning process (Celik, Onder, & Silay, 2011). Physics is a branch of science that requires students to be able to solve various complex and multi-concept problems, so physics learning should be used as an exercise for students to be able to have problem-solving skills. However, what happens in the field is that many students solve physics problems simply by entering formulas without knowing the concepts. This makes the problem-solving skills of students are still relatively low.

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Worse yet, this condition is also still found in many universities where there are still many students who do not have good problem-solving skills. This is indicated by the student's argument that physics is just a formula. If these students have good problem-solving skills, they will realize that solving physics problems cannot be solved by using simple formulas and mathematical calculations but requires basic concepts and the relationships or relationships between these concepts.

The low problem-solving skills of these students can be caused by several things, one of which is the lack of learning innovation carried out by educators. Learning innovation can be done by using a learning approach that is by with the material needs and characteristics of students so that students are trained to have problem solving skills. A learning approach that is by with the demands of the 21st century, namely a learning approach by integrating various sciences, namely Science, Technology Engineering and Mathematics or known as STEM (Corlu, Capraro, & Capraro, 2014).

STEM is proven to improve students' problem solving skills (Astuti, Rusilowati, & Subali, 2020). Learning using the STEM learning approach is proven to improve problem solving skills in dynamic electrical material. The indicators of problem-solving ability measured include a) the ability to focus on problems, b) the ability to describe the problem into physics concepts, c) the ability to design solutions, d) the ability to realize the design solution, and e) the ability to evaluate the results of the answers (Dewi et al., 2018; Lestari, 2019). STEM also makes students more independent and able to solve problems well (Stohlmann, Moore, & Roehrig, 2012), STEM requires students to solve problems and become well-defined results through peer collaboration (Han, Capraro, & Capraro, 2015).

However, the success of implementing the STEM approach in the learning process needs to be reviewed at schools or colleges with different characteristics than usual, such as in Islamic boarding schools. Where the characteristics of students are of course different from universities in general. The following are the characteristics of students in Islamic boarding schools: 1) the majority of boarding-based tertiary students are santri so that there is limited time in carrying out learning because they have to divide their time between assignments as students and assignments as santri, but this is not a disadvantage but can be an advantage because they have good time management skills 2) the majority of pesantren-based tertiary students come from lower-middle family conditions so that they have limitations in terms of the availability of technology such as laptops and cellphones 3) the majority of pesantren-based tertiary students come from schools with lower quality schools. average so that they have never been trained to have 21st century skills.

This paper will describe 1) the effect of implementing the STEM approach on students' problem-solving abilities at Islamic boarding schools in terms of educational background (santri-non-santri, availability of technology and academic ability 2) the challenges and effectiveness of implementing STEM in pesantren-based universities. The results of the research can be used as a basis for consideration for educators at Islamic boarding schools to apply STEM to the learning process that will be taught.

Table 1. STEM Literacy (Hidayat et al., 2017)

Knowledge field	Literacy
Science	The ability to use science and processes to understand the surrounding problems and the ability to make decisions in solving a problem
Technology	Ability to use, understand and analyze a new technology
Engineering	The ability to use science and knowledge to produce a work in a way that integrates various sciences
Mathematic	Ability to analyze, formulate, solve, and interpret the solution of a mathematical problem in its application

Method

The method used in this research is pre-experimental with research design using One Group Pretest-Postettes Design. This design uses an experimental class without using a control class. The effect of STEM learning with students' problem-solving skills is seen from before giving treatment and after giving treatment. The population in this study were all physics education students at the Islamic University of Madura. The research sample is level 3 students, the determination of the sample is done by using a cluster random sampling technique, which is done randomly.

The sample in this study we grouped into 3 categories, including 1) A sample consisting of 26 physics education students who were given a learning treatment using a STEM approach which was then given a pretest and posttest to determine the effect of applying STEM on students' problem-solving abilities 2) The sample consisted of a group low academic ability and high academic ability. Academic ability is seen from the GPA taken for 5 semesters, a GPA of more than 3.5 is grouped into high academic ability and a GPA of less than 3.5 is grouped into low academic ability and each group has a total of 13 students. This sample group was given the STEM approach treatment and was given a pretest and posttest to determine the effect of STEM on students' problem-solving abilities based on academic ability 3) samples were grouped based on the status of students and non-students to determine the effect of

applying STEM on students' problem-solving abilities based on the status of students or not. The materials used are electricity and magnetism. This research was conducted for one semester or during lectures on electricity and magnetism.

The variables of this study consisted of 3 variables, including 1) the independent variable, namely the ability to solve physics problems, 2) the dependent variable, namely the STEM approach and 3) the moderator variable, namely the academic ability and student status (students and non-students). The instrument used in this study is a physics problem-solving ability test instrument based on indicators of problem-solving skills. The test instrument is an essay question consisting of 5 questions. Before being used as a test instrument, the questions have been tested for validity and reliability.

Hypothesis testing was done by using two-way ANOVA test to see the interaction between variables. Prior to the two-way ANOVA test, the data was previously tested for normality using Shapiro Wilk and homogeneity test using Levene's test. The ANOVA test was carried out with the help of SPSS 24 software. In addition to testing the hypothesis in this study, the N-gain test was also carried out to determine the improvement of students' problem-solving abilities and the effect size test to determine the effectiveness of the application of STEM on students' problem-solving skills.

Result and Discussion

Data on problem solving skills were obtained based on the results of the pretest and posttest of 26 physics education students by providing STEM learning treatment. The description of the data on the problem-solving skills of students in this category is shown in Table 2. The average post-test score of students' problem-solving skills was 76.42, the value was higher than the average pre-test score of 50.65. The results of the normality test showed that the pretest and posttest data were normally distributed with a significance value > 0.05. The homogeneity test results also showed homogeneous data with a significance > 0.05. With the fulfillment of these two conditions, then the hypothesis test was carried out using a two-way ANOVA test and obtained a significance result of <.05, which means that there is a significant difference between the pretest and posttest scores after applying the STEM approach to learning.

Results should be clear and concise. The discussion should explore the significance of the results of the work, not repeat them. A combined Results and Discussion section is often appropriate. Avoid extensive citations and discussion of published literature.

Meanwhile, the improvement of students' problem-solving skills is shown by the N-gain analysis and a value of 0.58 is obtained, which means that there is an increase in students' problem-solving skills from before being given treatment to after being given STEM learning treatment. Meanwhile, the effect size value is 2.77, which means that the effectiveness of STEM implementation is very high.

Table 2. Descriptive analysis Result of Pretest Posttest Data

Type	Analytical Problem-Solving Skills	
	Pretest Before Implementation STEM	Posttest After Implementation STEM
Mean	50.65	76.42
Maximum	55.00	95.00
Minimum	47.00	60.00
SD	2.382	9.305

In the second sample, to determine the effect of STEM on students' problem-solving skills based on academic ability, in this case the student's GPA. The results of the normality test and homogeneity test on the pretest-posttest data in groups of students with low and high academic abilities showed that the data were normally distributed with a significance value <0.05 and homogeneous with a significance value> .05. while the results of the two-way ANOVA test showed that the significance value of each pretest and posttest was <0.05 as like table 3, which means that there was a significant difference for each pretest and posttest scores between students with high and low academic abilities after the implementation of the STEM learning model.

Meanwhile, the improvement of students' problem-solving skills was shown by the N-gain analysis and obtained a value of 0.53 for students with academic abilities and 0.59 for students with low academic abilities. This value indicates that the increase in problem solving skills after the application of STEM increases for both high and low academics. Likewise, the effect size value shows a number more than 1 which means the effectiveness of STEM is very high.

Table 3. Descriptive analysis Rsult of Pretest Posttest Data based on academic ability

Type	Analytical Problem-Solving Skills			
	IPK > 3.5		IPK < 3.5	
	Pretest Before STEM	Posttest After STEM	Pretest Before STEM	Posttest After STEM
Mean	52.00	82.38	49.31	70.46
Maximum	55.00	95.00	54.00	85.00
Minimum	49.00	70.00	47.00	60.00
SD	1.780	7.556	2.175	6.802

Unlike the case with the sample grouped by students and non-students, the results of normality and homogeneity showed normal and homogeneous, but the two-way ANOVA test showed no significant difference between students with the status of students and non-

students. Which means that the application of STEM learning to improve students' problem-solving skills does not affect the status of students as students or non-students.

The results of the ANOVA test also show a correlation between the three, based on Table 6, it was found that there is a correlation between academic ability and student problem solving abilities. Which means that being a student is not a reason for students not to have problem-solving skills.

Table 5. Descriptive analysis Result of Pretest Posttest Data based on Santri and Nonsantri

Type	Analytical Problem-Solving Skills			
	Santri		Non Santri	
	Pretest Before STEM	Posttest After STEM	Pretest Before STEM	Posttest After STEM
Mean	51.23	77.23	50.08	75.62
Maximum	55	95	54	93
Minimum	47	60	47	65
SD	2.421	10.725	2.290	7.995

Table 6. Result of test ANAVA

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	9919.548[a]	7	1417.078	61.166	0.000
Intercept	197476.581	1	197476.581	8523.82	0.000
LP	3.154	1	3.154	.136	0.714
MODEL	8069.908	1	8069.908	348.327	0.000
IPK	826.308	1	826.308	35.667	0.000
LP * MODEL	14.058	1	14.058	.607	0.440
LP * IPK	38.504	1	38.504	1.662	0.204
MODEL * IPK	390.289	1	390.289	16.846	0.000
LP * MODEL * IPK	6.139	1	6.139	0.265	0.609
Error	1019.375	44	23.168		
Total	220870.000	52			
Corrected Total	10938.923	51			

a. R Squared = .907 (Adjusted R Squared = .892)

Conclusion

Students' problem-solving skills can be improved in various ways and one of them is by applying a learning model or learning approach that is in accordance with the learning objectives. as well as the application of the STEM approach. Several countries in the world have implemented STEM in their educational curricula such as in Malaysia, STEM has been applied since elementary school and it is proven that STEM can improve students' problem solving abilities (Argaw, Haile, Ayalew, & Kuma, 2016). STEM learning is a learning approach solution that is appropriate to be applied, especially in improving students' problem solving skills (Hasanah, Huda, & Kurniawati, 2017).

Reference

Argaw, A. S., Haile, B. B., Ayalew, B. T., & Kuma, S. G. (2016). The effect of problem based learning (PBL) instruction on students' motivation and problem solving skills of physics. *Eurasia Journal of Mathematics, Science and Technology Education, 13*(3), 857-871. https://doi.org/10.12973/eurasia.2017.00647a

Arini, A. N., Hartono, H., & Khumaedi, K. (2019). Analysis of Problem Solving Skills and Students Scientific Attitudes through the Implementation of Problem Based Learning Module. *Journal of Innovative Science Education, 8*(1), 68-75. https://doi.org/10.15294/jise.v7i2.24822

Astuti, N. H., Rusilowati, A., & Subali, B. (2020). STEM-Based Learning Analysis to Improve Students' Problem Solving Abilities in Science Subject: a Literature Review. *Journal of Innovative Science Education, 9*(2), 79-86. https://doi.org/10.15294/jise.v9i2.38505

Barak, M. (2017). Science teacher education in the twenty-first century: A pedagogical framework for technology-integrated social constructivism. *Research in Science Education, 47*(2), 283-303. https://doi.org/10.1007/s11165-015-9501-y

Binkley, M., Erstad, O., Herman, J., Raizen, S., Ripley, M., Miller-Ricci, M., & Rumble, M. (2012). Defining twenty-first century skills *Assessment and teaching of 21st century skills* (pp. 17-66): Springer. http://dx.doi.org/10.1007/978-94-007-2324-5_2

Celik, P., Onder, F., & Silay, I. (2011). The effects of problem-based learning on the students' success in physics course. *Procedia-Social and Behavioral Sciences, 28*, 656-660. https://doi.org/10.1016/j.sbspro.2011.11.124

Corlu, M. S., Capraro, R. M., & Capraro, M. M. (2014). Introducing STEM education: Implications for educating our teachers in the age of innovation. *Eğitim ve Bilim, 39*(171), 74-85.

Dewi, M., Kaniawati, I., & Suwarma, I. R. (2018). *Penerapan pembelajaran fisika menggunakan pendekatan STEM untuk meningkatkan kemampuan memecahkan masalah siswa pada materi listrik dinamis.* Paper presented at the Quantum: Seminar Nasional Fisika, dan Pendidikan Fisika.

Griffin, P., Care, E., & McGaw, B. (2012). The changing role of education and schools *Assessment and teaching of 21st century skills* (pp. 1-15): Springer. http://dx.doi.org/10.1007/978-94-007-2324-5_1

Han, S., Capraro, R., & Capraro, M. M. (2015). How science, technology, engineering, and mathematics (STEM) project-based learning (PBL) affects high, middle, and low achievers differently: The impact of student factors on achievement. *International Journal of Science and Mathematics Education, 13*(5),

1089-1113. https://doi.org/10.1007/s10763-014-9526-0

Hasanah, T. A. N., Huda, C., & Kurniawati, M. (2017). Pengembangan Modul Pembelajaran Fisika Berbasis Problem Based Learning (PBL) pada Materi Gelombang Bunyi untuk Siswa SMA Kelas XII. *Momentum: Physics Education Journal*, 56-65. https://doi.org/10.21067/mpej.v1i1.1631

Hidayat, S. R., Setyadin, A. H., Hermawan, H., Kaniawati, I., Suhendi, E., Siahaan, P., & Samsudin, A. (2017). Pengembangan instrumen tes keterampilan pemecahan masalah pada materi getaran, gelombang, dan bunyi. *Jurnal Penelitian & Pengembangan Pendidikan Fisika, 3*(2), 157-166. https://doi.org/10.21009/1.03206

Lestari, I. F. (2019). Pendekatan Science, Technology, Engineering, and Mathematics (STEM) untuk Meningkatkan Kemampuan Pemecahan Masalah Fisika Siswa pada Konsep Tekanan Hidrostatis. *Jurnal Pendidikan UNIGA, 13*(1), 215-221. http://dx.doi.org/10.52434/jp.v13i1.831

Stohlmann, M., Moore, T. J., & Roehrig, G. H. (2012). Considerations for teaching integrated STEM education. *Journal of Pre-College Engineering Education Research (J-PEER), 2*(1), 4. https://doi.org/10.5703/1288284314653