

# Mastery of STEM-Based Research Approach of Science Teachers in Jakarta

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## ARTICLE INFO

### Keywords:

STEM approach;  
Research-based;  
Science teachers

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### Article history:

Received 2022-03-23

Revised 2022-06-21

Accepted 2022-09-20

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## ABSTRACT

The STEM approach is the right innovation developed at this time to improve the quality of science learning according to the needs of students in 21st century. The purpose of this study was to identify the mastery of STEM-based research approach of science teachers in Jakarta. The research subjects were elementary, middle and high school teachers in DKI Jakarta, totaling 40 teachers. Sampling is done by purposive sampling technique. Technique and instrument for collecting data on mastery of STEM-based research approach of science teachers using multiple choice test. Data analysis using t-test using SPSS 20. The results showed that the value of sig (2-tailed) mastery of STEM-based research approach of science teachers (posttest)  $< 0.05$ . It can be concluded that there is a difference in the average of the mastery of STEM-based research approach of science teachers of the experimental class and control class. The recommendation of this research is that in this era of digitalization and global competition, teachers are required to use a learning approach that encourages students to understand science, technology, experimentation and work so that the STEM approach needs to be applied in learning.

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## 1. INTRODUCTION

The development of knowledge and technology is in line with the improvement of education quality at school, especially in adopting technology. Technology application in teaching simplifies the teaching process and broadens access the unlimited information anywhere anytime. Today, in industry revolution era 4.0, schools are demanded to innovate to deal with the fastest growing technology. Thus, teachers should be able to utilize technology development in teaching to increase students' skill and intelligence (Hermino & Arifin, 2020). Teaching model is an important component in teaching process (Arsyad, 2016). The application of the appropriate model in teaching process plays a role in improving teaching target and it enables to motivate students as well. Selecting the applicable teaching model is important to improve learning result, especially in teaching science. Teaching science needs a real

teaching model such a project-based learning. The objective of developing model is to involve students actively during teaching learning process and improve students' understanding by creating, utilizing, choosing a model to describe, explain, predict and control physic phenomenon. Therefore, teachers do not require students to memorize teaching material for their subject but acquiring the needed skill by applying the right teaching model in the classroom.

The development of the times makes the demands in the world of education are getting higher. The world of education is expected to produce students who are ready to contribute in the world of work and can solve everyday problems. Facing revolution 4.0 requires education with an approach that can equip students to be able to communicate, collaborate, think critically and solve problems, as well as be creative and innovative so that students are ready to face global challenges (Mulyani, 2019). STEM in learning has become a focus in increasing the dimensions of students' knowledge, attitudes, and skills. STEM education focuses on three themes: acquiring problem solving skills, being innovative and able to design because STEM in education aims to bring individuals at an interdisciplinary level covering the fields of Science, Mathematics, Engineering and Technology (Korkmaz et al., 2020). STEM education is also evaluated as a bridge between education and career for students (Hacioglu & Gulhan, 2021).

Some of the benefits of the STEM approach are helping students become better problem solvers, innovators, inventors, independent, logical thinkers and technologically literate (Stohlmann et al., 2012). STEM has been applied in a number of developed countries such as the United States, Japan, Finland, Australia and Singapore (Permanasari, 2016). Several studies have proven that STEM is suitable to be applied in schools. Cotabish & Dailey (2013) showed that there was a statistically significant gain in the science process skills of elementary school students who participated in the basic STEM program for a year. (Mu'minah & Aripin, 2019) stated that science learning-based STEM and ICT can improve 21st century skills. One of the appropriate approaches in teaching science is using Science, Technology, Engineering and Mathematic (STEM). STEM is an approach in which it collaborates four different science subjects; science, technology, engineering and mathematic, as a holistic unit. (Roberts, 2012). The objective of Science, Technology, Engineering, and Mathematics (STEM) in education is in accordance with 21st century education principle that is enabling the students to acquire science and technology literacy which perceived in reading, writing, observing, conducting and developing an acquired competence to be applied in daily life problem.

Science is included in the main scope of STEM learning so that the application of STEM in science learning needs to be developed. Based on a study of the many benefits of STEM in learning, it is necessary for teachers who are experts and reliable in implementing STEM in the classroom. Teachers are one of the most important factors in education. Teachers become role models for students who will affect academic achievement and student personality (Handoyo, 2021). The image of science teachers in the eyes of students can affect their understanding of the nature of science (Durukan & Paliç Şadoğlu, 2018). Teachers should be provided with a qualified education both pedagogically and in accordance with the particular science they are engaged in.

Teacher professionalism in Indonesia is still in the low category (Hoesny & Darmayanti, 2021). The results of the science learning survey stated that there was no optimal use of the laboratory, too high a load of mathematical concepts and approaches (PPPPTK, 2020). The learning applied by the teacher has not been able to develop process skills, understanding of the material is not optimal and students' motivation to learn science is still low so that training is needed to improve pedagogical abilities. The problems found are expected to have gaps that do not continue to widen, so preventive and curative solutions are needed. One of them is to strengthen the competence of science teachers through a planned and sustainable training process. A clear understanding of STEM by teachers can be a continuous support for the formation of a higher and better quality of STEM professional development. Based on the description above the question of this research is how to mastery the STEM-based science teacher research approach in Jakarta. Re-charging science teachers in strengthening a good learning process will have leverage on student achievement in learning.

## 2. METHODS

The purpose of this study was to identify the mastery of STEM-based research approach of science teachers in Jakarta. The research approach used is descriptive quantitative approach (Sugiyono, 2018). The research subjects were elementary, middle and high school teachers in DKI Jakarta, totaling 40 teachers. Sampling is done by purposive sampling technique. Technique and instrument for collecting data using multiple choice test to collect data of the mastery of STEM-based research approach of science teachers. The difference of mastery of STEM-based research approach of science teachers was tested using t-test. Data analysis using statistical t-test techniques requires prerequisites that must be met, including normality and homogeneity of the data.

## 3. FINDING AND DISCUSSION

### *Mastery the STEM-based Science Teacher Research Approach*

Technical guidance as an effort to increase the competence of educators based technology related to the STEM approach is carried out aiming to identify teacher readiness and mastery of the STEM approach carried out on elementary, middle and high school teachers. Data of mastery of STEM-based research approach of science teachers was measured using pretest questions given before learning and posttest given after learning in the experimental class and control class. The data obtained from the pretest and posttest were then analyzed by descriptive statistics. The description of the mastery data on the teacher's STEM approach before and after treatment is presented in Table 1.

**Table 1.** The result *pretest* dan *posttest* mastery of the teacher's STEM approach

Data	Treatment	Class	N	Ideal Value	Max. Value	Min. Value	Average	Standard Deviation
<i>Pretest</i>	Control eksperiment	A	20	100	53,00	15,00	35,70	5,247
		B	20	100	50,00	20,00	35,10	6,062
<i>Posttest</i>	Control eksperiment	A	20	100	92,00	65,00	82,32	5,478
		B	20	100	77,00	60,00	73,93	3,389

The normality test for mastery of the teacher STEM approach was carried out using the Kolmogorov-Smirnov test which aims to determine the alignment or suitability of the data with a normal distribution or not. Table 2 shows that the pretest score for mastery of the teacher's STEM approach obtained a sig value of  $0.227 > 0.05$ , so it can be concluded that the data is normally distributed. The posttest value of mastery of the teacher's STEM approach obtained a sig value of  $0.161 > 0.05$ , so the data is also normally distributed.

**Table 2.** Test normality of mastery the teacher's STEM approach

	Kolmogorov-Smirnov <sup>a</sup>			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
<i>Pretest</i>	,227	20	,227	,908	20	,127
<i>Posttest</i>	,143	20	,161	,940	20	,220

The results of the homogeneity test using Levene's test showed that the pretest and posttest data for mastery of the teacher STEM approach had the same variance (homogeneous) because the significance value was greater than the 0.05 significance level (Table 3).

**Table 3.** Test homogeneity of mastery the teacher's STEM approach

	<i>Levene Statistic</i>	<i>df1</i>	<i>df2</i>	<i>Sig.</i>
<i>Pretest</i>	,185	1	40	,496
<i>Posttest</i>	,357	1	40	,288

**Table 4.** Results of the independent sample t-test mastery of the teacher's STEM Approach

<i>Dependent Variable</i>	<i>t-test for Equality of Means</i>			<i>Description</i>
	<i>t</i>	<i>Df</i>	<i>Sig. (2-tailed)</i>	
Mastery of the teacher STEM approach (pretest)	-,152	40	0,612	There is no difference in the average mastery of the STEM approach of the experimental class and control class teachers
Mastery of the teacher STEM approach (Posttest)	-11,934	40	0,000	There is a difference in the average mastery of the STEM approach of the experimental class and control class teachers

Based on Table 4, it can be seen that the value of sig (2-tailed) mastery of the teacher's STEM approach (pretest)  $> 0.05$  then  $H_0$  is accepted and  $H_a$  is rejected which means there is no difference in the average mastery of the STEM approach of the experimental class and control class teachers, while the sig value (2-tailed) mastery of the teacher's STEM approach (posttest)  $< 0.05$  then  $H_0$  is rejected and  $H_a$  is accepted which means there is a difference in the average mastery of the STEM approach of the experimental class and control class teachers.

During this technical training, elementary, middle and high school teachers in DKI are taught about the standard framework of STEM education, the STEM approach in science learning, STEM-based science learning assessment, research in learning, and research integration in the STEM approach, so that from this activity teachers will be able to develop professionalism, pedagogical skills and the ability to understand the curriculum so that they are truly ready to implement the STEM approach in learning. In addition, the technical guidance that has been carried out can develop the knowledge, attitudes and skills of teachers about the STEM approach in schools/madrasahs.

Based on the analysis of the data obtained, it shows that there is a difference in the average mastery of the STEM approach of the experimental class and control class teachers. Elementary, middle and high school teachers were very enthusiastic during the technical guidance for mastering this research-based STEM approach. Most teachers know about the STEM approach but to dig deeper, it is necessary to know further the initial understanding that teachers have about the STEM approach. Therefore, teachers need to get an adequate understanding so that the STEM-based learning process can be carried out as expected. Teachers should be given regular training to improve their pedagogical knowledge and skills so that they can implement the STEM approach effectively (Siew et al., 2015). Clear knowledge of STEM and the integration of STEM aspects can be meaningful as a solid foundation for forming a superior quality of STEM professional development in a sustainable manner (Paramita et al., 2019). The technical guidance carried out can accommodate the teacher's ability to plan, implement and evaluate a research-based STEM approach that is more creative, innovative and effective in teaching science. This technical guidance also has a good impact on the perceptions and conceptions of elementary, middle and high school teachers about STEM.

Teachers with 21st century skills can be obtained by mastering the STEM approach, although its application at several levels of education is still on a very small scale. The first implementation of STEM education in Indonesia was carried out in 2013 which began with teacher training activities, content analysis of the 2013 curriculum and KTSP as well as STEM-based training activities (Firman et al., 2016). Until now, the implementation of STEM education at the secondary school level in Indonesia is still

being developed considering its benefits in developing students' skills. Therefore, there must be careful preparation for teachers to develop STEM-based learning. Science, Technology, Engineering and Mathematics (STEM) is an approach that is formed based on a combination of several disciplines, namely science, technology, engineering and mathematics (Raisah, 2018).

The application of STEM in learning will help students to collect, analyze and solve problems that occur and be able to understand the relationship between a problem and other problems (Mulyani, 2019). STEM will train students to apply their knowledge to design solutions to problems related to the environment by utilizing technology. The urgency of STEM-based learning includes (1) increasing students' mathematical correlation skills (Ni et al., 2018), (2) improving students' critical thinking skills (Hafni et al., 2020); (Rosikhoh et al., 2019), (3) increasing students' creative thinking skills (Puspandari & Supraman, 2018), (4) improve logical and systematic thinking skills (Anggraini & Huzaifah, 2017) and (5) improve students' problem solving abilities (Dewi et al., 2018).

Teacher readiness is required to be able to keep up with the rapid globalization. In this era of digitalization and global competition, a learning approach that encourages students to understand science, technology, experiment and work is needed so that the STEM approach needs to be applied in learning. Teachers must prepare carefully for this approach. Teacher readiness will be formed from their experience and understanding in creating learning according to STEM in the classroom. If in its application in learning, teachers experience problems related to facilities and costs, the teacher can modify learning with a STEM approach according to existing conditions.

Teachers implementing STEM learning are expected to be able to carry out various approaches to bring up 21st century integrated STEM skills in students. STEM learning is expected to be able to contribute material and understand the understanding of basic concepts to teachers to be applied so that students are trained earlier in facing educational changes in today's era.

#### 4. CONCLUSION

Based on the results of the research it can be concluded that the mastery of STEM-based research approach of science teachers (*posttest*)  $< 0.05$ , it means that there is a difference in the average of the mastery of STEM-based research approach of science teachers of the experimental class and control class. The recommendation of this research is that in this era of digitalization and global competition, teachers are required to use a learning approach that encourages students to understand science, technology, experimentation and work so that the STEM approach needs to be applied in learning. The limitation of this study is that the results of this study cannot be generalized because the research subjects are limited to only elementary, junior high, and high school teachers in DKI Jakarta, amounting to 40 teachers, so it needs to be carried out on a large population of all science teachers combined at the provincial and national levels.

**Acknowledgments** : Thanks are due to PPPPTK IPA KEMDIKBUDRISTEK and MAJELIS DIKDASMEN PWM DKI Jakarta for their cooperation in this research.

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