IMPLEMENTATION OF SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS (STEM)

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RESEARCH ARTICLE

IMPLEMENTATION OF *SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS* (STEM) LEARNING APPROACH TO REDUCE GENDER DISPARITY IN SCIENCE LEARNING ACHIEVEMENT.

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Abstract

The learning activities in the classroom cannot be separated from their models and approaches for the launch learning activities and improve the understanding of the concept and the intelligence of learners must be balanced with utilizing learning approach. One form of approach that supports independent learning process is Integrated Approach Science, Technology, Engineering, and Mathematics (STEM). This research is a quasi-experimental study. Results of samples paired t-test showed Sig.(2-tailed) 0.000 means there are difference[illegible]n results pretest and posttest supported the test results that show the value of the effect size effect size of 0.90 for the experimental class men and 0.99 for women classified experimental large class. The test results independent sample t-test showed Sig.(p-value) to 0.782 posttest and 0.392 for N-Gain, showed no difference in the average understanding of the concept and according to test results. Analysis of Covariance Data posttest Sig.(p-value) 0.782 and N-Gain Sig.(p-value) 0.392, there was no difference in aver[illegible] learners' understanding of the concept of male and female. Thus, it can be concluded that with STEM-based approach to Problem Based Learning which have been tested can be used as an approach to reduce gender disparities and enhance participants understanding of the science concept.

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Introduction:-

Gender is a social concept and influence science education of students in many ways. Gender someone drafted in conjunction with other social categories such as ethnicity, class, race, religion, and language. Schools and other educational institutions rely on interactions between individuals and groups to be able to function. According to (Ridwan, 2006: 25) The gender difference in principle is something that is fair and is a gift from birth as a cultural phenomenon.

Gender issues in the 21st century science has discussed pedagogical practices, curriculum, techniques, and patterns of participation in science teaching and work in science at all stages of formal and informal environments. Suryadi and Idris (2004) revealed that educational background is not equivalent because of the existence of inequality or

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gender inequality. Gender inequality in the education sector has been a major factor that most affects the overall gender inequality. Gender equality in education should be a basic idea, objectives and main mission of human civilization to prosper, build a harmonious society, the state and build a quality family. Gender equality is a similarity of conditions for men and women as well as the opportunity to obtain their rights as human beings, to be able to contribute and participate in the activities of political, legal, economic, social, cultural, especially in the field of education. Equality and justice will be met if education is able to meet the educational foundation to deliver each individual or people get the education that can be called popular education.

Program for International Student Assessment (PISA), one study international test measures reading, mathematics and science in 2015 shows that Indonesia ranks 63 in mathematics, 62 for science, and 64 for the areas of reading from 70 countries. Index learners of men and women in the involvement of science, namely 8.6 and 22.1 Categories of women who have achievements than men in math also put Indonesia in a position to three of nine countries that are in the fourth grade. Results in other PISA there are gender inequalities in adulthood, namely the index reading is 386 males and 409 females. Involvement percentage index in employment 43.6% for men and 34.0% for women (OECD, 2016).

The research result *Trends International Mathematics and Science Study* (TIMSS) in 2015 that measure math and science achievement showed Indonesia get a score of 397 with an average TIMSS score of 500, placing Indonesia at number 45 out of 50 countries (IEA, 2016). These results suggest the involvement of learners of men and women in science is still a gap, and the involvement of men and women aged adults in the world of work there is also a gender gap. The involvement of women is less well in the field of STEM jobs consistently over the last decade. Relatively few women receive STEM jobs, in contrast to men, who are concentrated mainly in the field of engineering. Earnings for women working in STEM jobs is less than their male counter parts, they experience gender wage gap is smaller than the others in non-STEM jobs (Beede, et. al.,2011). A follow-up study of 513 college students revealed that women using the techniques of collaborative learning strategy is significantly less than men (Stump, et. al.,2011). Gateway to a lot of work is an undergraduate STEM high cost, it is important to examine the extent to which the college educated workers to master STEM. (ACS, 2009) provides a rich source of new data to analyze the relationship betweenstudies *undergraduate* and subsequent employment. Data ACS in the field of undergraduate studies show that women accounted for nearly half of college graduates who work at the age of 25 years and above, but only about 25 percent of degree holders STEM employed and a smaller part is only about 20 percent of graduate degree STEM work the STEM jobs.

It was necessary for us examine further what the cause and how to solve them. Results learners in learning physics can be seen from the mastery of concepts. While learners by age, gender, and ability tends to bring an understanding of concepts and misconceptions that come from personal experiences and results of social interaction. One of the concepts of physics that is closely related to the life and learners often have the wrong understanding of the concept is the concept of temperature and heat (Susanti, 2014). Other research results mentioned in the concept of temperature and heat, there are still misconceptions (Maunahand Wasis, 2014). In addition, the material temperature and the heat had a lot of concepts that are misconceptions (Hafizah, et al., 2014). Some researchers found that participants students argued temperature and heat are the same thing (Alwan, 2011).

Observation senior high school in Lampung Province, show that mastery of concepts among children of men and women still have not reached equality, where learners male will become more dominant if the learning in the classroom using the method of discussion and conduct experiments in the laboratory, while learners women will become more dominant if the teaching methods of lecture and question and answer questions. That's because learning approaches used are not varied since it uses a contextual approach.

The integrated approach is a learning approach that is performed using several disciplines. Science, Technology, Engineering and Mathematics (STEM) is a new integrative approach in the development of education (Sanders, 2009). Afriana (2017) explains that an integrated approach to STEM learning can improve scientific literacy of students in terms of gender with integrated STEM learning. Previous research by Blackley, et.al.(2018) stated that in STEM activities learners are encouraged to create their own visual form to represent their understanding of basic concepts that focus on problem solving authentic. Morrison (2006) which states that learners learn the STEM approach is able to solve the problem. In addition, research Wang, et. al., (2011) stated the multidisciplinary integration requires learners to connect the components of the various subjects.

Other research by Breiner, et.al., (2012) states STEM approach has the objective to remove the walls between each embedded in STEM education and to teach learners as one of the subjects in line with the results of this research have combined to four aspects of STEM learning STEM education as an interdisciplinary approach, in STEM approach learners are required to have knowledge and skills in the fields of science, technology, engineering and mathematics (Revee and Avery, 2013) will be able to solve the problems of gender in understanding the material concept of temperature and heat above.

Identification understanding of concepts or misconceptions is an important thing to do in the process of learning physics. The identification can be performed before, during, and after the learning process (Silung, 2015). Misconceptions have varying degrees between concepts (Thompson and Logue, 2006). Identification error will cause an error in how to overcome them, and the results are not satisfactory (Tayubi, 2005). Mosik (2015: 98-103) in research mentions that cognitive conflict approach can improve the understanding of the concept. Several studies have succeeded in developing an instrument diagnostics misconception that the results can be identified quickly and accurately, including Wahyuningsih (2013) make a test instrument understanding of the concept to the level of constancy in exposing the misconceptions of students is multiple choice two storey *(two-tier)* (Chou, 2002) with the added degree of confidence (Svandova, 2014) and a three-storey, multiple-choice *(three-tier)* (Caleon and Subramaniam, 2010) may increase the ease in identifying the understanding of the concept (Syahrul and Setyarsih, 2015). Development of *three-tier test,* among them more practical and can be managed easily by educators and researchers (Gurcay and Gulbas, 2015).

Although many previous studies on the influence of STEM approach to reducing gender disparities, but still a few who considers the influence of STEM approach to reducing gender disparities towards mastery of concepts, especially in the matter of heat learners. Interest authors conducted a study in an effort to (1) determine the effectiveness of the approach to solving the problems of gender disparities STEM (2) determine the effectiveness of STEM approach in improving the understanding of concepts (3) to identify an improved understanding of the concept of matter heat learners Class XI senior high school in Lampung.

Method of Research:-

The research used in this study is quasi-experimental. Figure 1 below describes the study design will be done by the researchers.

$O_1 \quad X_1 \quad O_2$
$O_3 \quad X_2 \quad O_4$

Figure1:-Experimental Design Pretest-Posttest Control Group

Description:-

X_1	:Class experiments male
X_2	:Class experiment female
O_1 and O_3	: Pretest
O_2 and O_4	: Posttest

Sugiyono (2015: 112):-

The quasi-experiments are experiments that have treatment and impact measurement, and experiment with the unit does not use random placement. The study design is a design *One group pretest-posttest* design. This study was conducted to provide treatment in the experimental class men and women are learning to STEM approach using a model *Problem Based Learning* (PBL) where do *test* learners' mastery of concepts before learning and after learning about the test instrument *three-tier test*.

The purpose of the test to determine the effect of learning using approaches scientific STEM based to gender disparities through the mastery of the concept of learners, and then observed the results, and then analyze the obtained data and make conclusions.

The research instrument used in this study is the syllabus, lesson plan (RPP), work-based learners STEM, and multiple choice test questions shaped reasoned. The test is given twice: *pretest* that serves to determine the students 'understanding of concepts before being given treatment and then performed *posttest* is to determine the students'

understanding of the concept of the final after being given treatment. Problem is given at time pretest and posttest consisting of 16 items.

Data collected through pretest and posttest after being given treatment, the data obtained in the form of numbers or the form of quantitative data. The shape of the test in the form of multiple choice questions reasoned ten items. Efforts to get the data understanding physics concepts students are accurate, then the tests used in this study had to meet the criteria for a good test data posttest is intended to look at the differences in understanding of the concept of learners after learning using STEM approach. To analyze the categories of student achievement test used score pretest, posttest, and N-gain normalized.

Table 1:-Interpretation of Gainnormalized

N-Gain	Interpretation
N-gain> 0,7	High
0,3 <N-gain ≤ 0,7	Medium
N-gain ≤ 0,3	Low

(Hake, 1999)

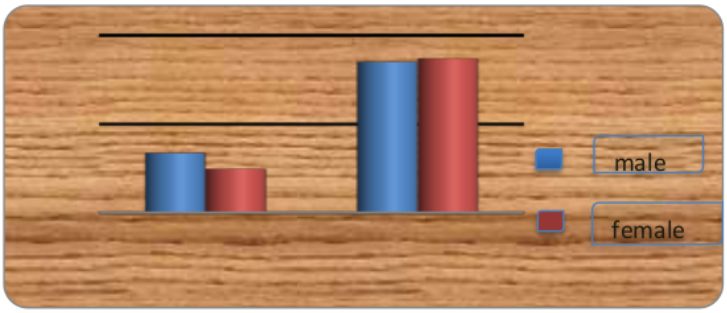
The instrument you want to use have been tested before hand through validity test and test reliability. Then performed some tests: (1) Test for normality (2) Test of homogeneity (3) paired sample t-test(4) test the effect size (5) Independent sample t-test (6) ANCOVA are statistical techniques which is a blend of regression analysis with analysis of variance or ANOVA (Rencher, 1998: 178). The primary outcome was to test whether the STEM approach can reduce gender disparity in understanding the concept of heat learners.

Result and Disscusion:-

The research was done in high school in lampung which began on January 19, 2018 as many as three sessions per class experiment with the allocation of 3 hours per meeting consisting of 45 minutes per hour. The results of this study in the form of quantitative data that consists of data mastery of concepts learners experimental class and women after learning experiment with the model of Problem Base Learning (PBL) approach based on Science, Technology, Engineering and Mathematics (STEM) the Heat material. Results of this research processed using *software* SPSS 21.0 application.

Table 2:-The average of data Cognitive Learning Outcomes of Students

Data	Male	Male
Average Pretest Value	43.00	38.16
Average Posttest Value	90.20	90.63
Averager N-gain Value	0.81	0.84



We do not yet know whether the STEM approach significantly influence the understanding of the concept and gender disparities. Therefore, it is necessary test statistic to examine whether the STEM approach can reduce gender disparities and improve the understanding of the concept of learners.

Table 3:-Normality pretest, posttest, N-Gain

Male	**Pretest**	0.585	H_0 accepted
	Posttest	0.369	H_0 accepted
Female	**Pretest**	0.093	H_0 accepted
	Posttest	0.196	H_0 accepted
N-Gain	**Male**	0.382	H_0 accepted
	Female	0.482	H_0 accepted

According to the above data shows that the data pretest, posttest, and N-Gain experimental class of men and women with normal distribution, for further tested homogentitas.

Table 4:-Homogeneity Test

Data	Levene Statistic	Sig.	Conclusion	Description
Pretest	2.012	0.161	H_0 accepted	Homogeneous
Posttest	0.249	0.620	H_0 accepted	Homogeneous
N-Gain	1.531	0.221	H_0 accepted	Homogeneous

After normality test, it can be concluded that the data pretest and posttest experimental class men and the experimental class of women with normal distribution. So that to verify that there are differences in the average or mean for free or sample independent pairs it is necessary to test paired sample t-test.

Table 5;-Paired Sample t-Test

Group	N	*Mean*	SD	Sig.(2-tailed)	Conclusion
Experiment Class Male	30	39.08	18:20	0.000	H_0 is rejected
Experimental ClassFemale	30	88.91	05.99	0.000	H_0 isrejected

From the above data can be seen in the graph below which shows an increase in pretest scores at the time of the posttest

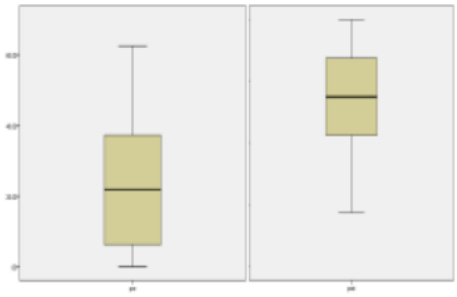


Figure 2:- Graph Value *pretest* and *posttest* Experiment Class offemale

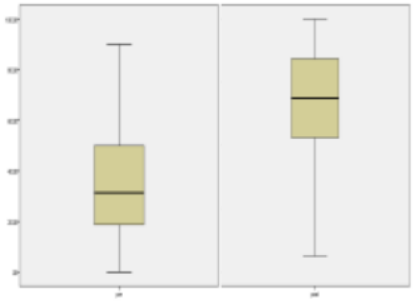


Figure 3:- Graph Value *pretest* and *posttest* Experiment Class of Male

Furthermore, in order to prove the extent of the impact effect STEM approach in improving the understanding of the concept do effect size obtained by calculating the effect size of 0.90 for the experimental class men and 0.99 for grade experiment female classified experimental *large* class according to Cohen (1998) .
As for the t-test unpaired classes shown in Table 6 below:

Table 6:-Independent Sample T-Test

Group	**N**	**Sig**	**Std. *error.***	**Sig(2-tailed)**	**Conclusion**
Posttest	30	6:20	1.55	0.782	H_0 accepted
N-Gain	30	2. 21	12.31	0.392	H_0 accepted

Analysis of covariance or ANCOVA is often called a statistical technique which is a combination of regression analysis with analysis of variance or ANOVA (Rencher, 1998: 178). Analysis of covariance is a statistical analysis to determine the effect of one or more independent variables on the dependent variable to consider one or more concomitant variables.

Table 7:-ANCOVA on *posttest*

Group	**N**	***Mean***	**SD**	***Sig***	**F**	
Male	30	90.20	6.26	0782	0.07	
Female	30	90.63	5.80	0782	0.07	

Table 8:-ANCOVA on *N-Gain*

Group	**N**	***Mean***	**SD**	***Sig***	**F**	
Male	30	0.81	0.12	0.392	0.745	
Female	30	0.84	0.09	0.392	0.745	

Effect *Science, Technology, Engineering and Mathematics* (STEM) Approach in the Gender Disparity educing:-

Exposure conceptual understanding test results above show that learners are men and women have the same understanding of the concept. This is evident in the test independent sample t-test values (2-tailed)≥ α (α: 0.05), H_0 accepted meaning there is no difference in the average understanding of the concept of learners. It happened because of the design of STEM learning is a learning process sequence from start to understanding science, preparing design engineering science, to create a product of the ideas of science and engineering of science design.

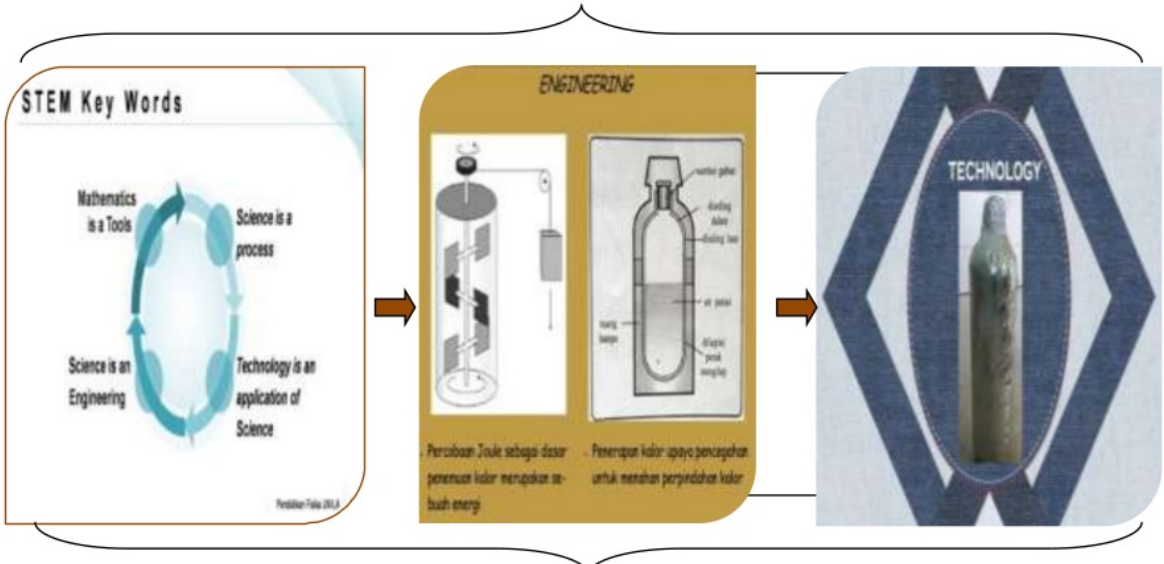


Figure 4:-Concept structure of STEM approach

Learning below shows the ability of learners in aspects of *engineering* and mathematics.

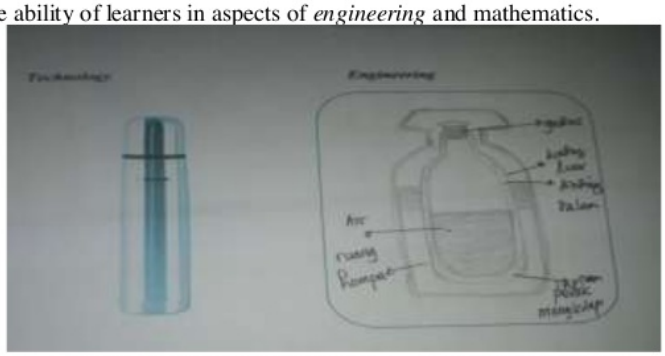


Figure 5:-Students understanding in Aspects Engineering

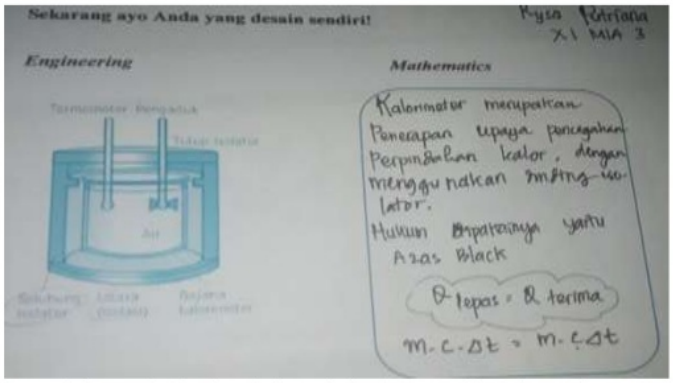


Figure 6:-Students' formula in Aspects of Mathematics

Influence of Science, Technology, Engineering and Mathematics (STEM) in Improving Students Concept Training:-

These results indicate that this approach affects the understanding of the concept STEM learners as indicated by the increase inresults posttest of learners male and female with the results Paired of sample T-test showed Sig.(p-value)<α (α: 0:05) means that $H_{0\ is}$ rejected no difference in the average results of pretest and posttest experimental class male and female experimental class after using STEM learning. Analysis has answered the second problem formulation that effect the understanding of the concept STEM learners. In figure 2 and 3 above shows that after the experiment the experimental class men and women an increase in value posttest compared pretest.

Increasing Understanding of Concept of Students by Using Science, Technology, Engineering and Mathematics (STEM) :-

Results for N- gain value in the study showed good results with very high criteria, the activities of the Science, Technology, Engineering and Mathematics (STEM), the participants are encouraged to create a visual form of their own to represent the understanding of the basic concepts that they focus on problem solving authentic or manufacture of the product, including the application of product design, for example, express opinions, creation, testing, repairing aimed at scaling up of understanding of the concept of learners. By learning so much fun as it is, then any learners are given the opportunity to express and carry out their research plans of each to solve problems that would occur gender equality understanding of the concept because in the learning activities of each learner men and women were given opportunities together to think about the concept of science,designing rekaya science,to make the product as the application and use mathematics as a tool. Learning activities in the classroom between men and women creates a social interaction which also can reduce gender disparity.

Conclusion:-

Based on the findings above, the conclusion that can be drawn in this study were

1. Approach STEM reduce dispartitas gender on students understanding the material of heat indicated by the similarity of the average posttest 90.20 experimental class of men and 90.63 for female class.
2. Approach STEM affect learners' understanding of the concept experiment class men and women in the matter of heat indicated by the value of the effect size of 0.90 for the experimental class men and 0.99 for women classified experimental large class.
3. The STEM approach is well used to improve understanding of the concept of learners with N-gain of 0.81 for the experimental class men and 0.84 for women classified experimental class high.

Based on data from the conclusions that have been obtained, the suggestions can be put forward, namely: Teachers are expected to use the approach to Science, Technology, Engineering and Mathematics (STEM) to facilitate learners in understanding the phenomenon of everyday life related to heat and can make an engineering and implementation science and make learners more independent with an integrative approach with preparing learning tools such as (1) lesson plan integrated STEM (2) Worksheet students integrated STEM (3) Instrument tests have proven the validity and regularity (4) Rubric to assess performance of learners during the learning (5) teaching materials in accordance with the basic competencies.

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