STEM INTEGRATED CHEMISTRY LEARNING EFFECTIVENESS (SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS) IN THE TIME OF COVID-19

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Abstract. *The purpose of this study was to determine the effectiveness of STEM (Science, Technology, Engineering, and Mathematics) integrated learning on the material of molecular form for Class X MIA MA Al-Khoiriyah students. The research design used in this research is descriptive analysis. The stages of this research consist of 3 (three) stages, namely pre-research, testing the validation of research tools, and implementing STEM integrated learning. As for knowing the effectiveness is measured by indicators, namely the level of student learning completeness after integrated STEM learning activities and the resulting STEM products. From the analysis of the final test, it can be seen that of the ten students who were the research subjects, 80% had achieved completeness and the resulting STEM product was in the good category so it can be concluded that STEM integrated learning is effectively used in molecular geometry learning.*

Keywords: *Effectiveness, STEM, Chemistry, Molecular geometry*

INTRODUCTION

The field of chemistry studies should be a fun subject, because it relates to everyday life. However, what is expected is generally different from reality. Until now, chemistry learning in its implementation still faces many problems, because students consider chemistry lessons to be complicated. One of the factors that influence this is that students think that chemistry lessons are difficult to understand, especially with the presence of abstract materials and calculations that become a burden for students.

The Covid-19 outbreak is sweeping the world, including Indonesia. Covid-19 is a type of disease that is easily transmitted. The impact caused by Covid-19 occurs in various fields such as social, economic, tourism, and education. The Minister of Education and Culture of the Republic of Indonesia issued Circular Letter Number 4 on March 24, 2020 regarding the implementation of education policies during the emergency period of the spread of Covid-19. The Circular explains that the learning process is carried out at home through online learning/distance learning (PJJ). PJJ requires teachers to still be able to carry out effective learning, which is not boring and of course the knowledge given must still be conveyed to students well [1].

Based on the results of pre-research interviews with MA chemistry teachers who are members of MGMP KKM 05, Gresik Regency, it is said that students often complain of difficulty distinguishing ionic, covalent, and metallic bonds and drawing molecular shapes. The results of the pre-study questionnaire analysis showed that students considered thermochemical material, solution stoichiometry, acid-base titration, buffer solution, hydrolysis, solubility and solubility product as well as chemical bonds (molecular shape) to be difficult because of the many varied and abstract formulas [2].

Mezia, said that the characteristics of chemical bonds (molecular shapes) are abstract concepts so that they have a high level of difficulty to be studied and understood so that the average learning outcomes of molecular shapes are low because students do not master the material of molecular shapes with well, students only memorize the material when working on questions [3]. The results of Fauziyah's research regarding the difficulties and factors that influence the learning difficulties of class X IPA students at SMA Negeri 4 Malang on chemical bonding material show that 47.5% of students understand the concept of elemental stability; 34.3% of students understand the concept of Lewis structure; 46.7% of students understand the concept of ionic bonding; 42.5% of students understand the concept of covalent bonds; 40.7% of students understand the concept of coordinating covalent bonds; 43% of students understand the concept of polar-nonpolar covalent bonds; 42.2% of students understand the concept of metallic bonds and 40% of students have difficulty drawing molecular shapes. The value of the percentage of students' understanding of the concept belongs to the low category [4]. Based on the description, it can be concluded that students do not understand the material in the form of molecules as a whole.

The solution to overcome the weaknesses that occur in the learning process mentioned above is also to apply 21st century learning in molecular form materials with STEM integrated learning. STEM is a modern approach to solving problems in the 21st century that requires students to be able to innovate, especially in learning. Based on developmental theory, high school students are in formal operation, meaning they are able to reason using abstract concepts, can provide logical and critical arguments for problem solving [5]. STEM is learning with the task of making projects in the form of products. The learning steps start from determining the basic questions, students are given project assignments to make products. This task can be done in groups. In this activity, students discuss in groups to determine the experimental procedure for the product to be made. Students will collect information from various sources regarding related products and how to make them. With this activity, students can learn directly and independently about the material in molecular form so that learning is more meaningful and easy for students to absorb.

STEM learning is carried out in this study, where students are asked to make products in the form of molecules from materials that are environmentally friendly and easily available around the students' residences. Due to the Covid pandemic period and learning is carried out with limited face-to-face meetings, the manufacture of products (molecular forms) is carried out in their respective homes and when the manufacturing process is videoed so that assessments can be made during the manufacturing process and also from the products produced.

The results of Permanasari's research that the application of STEM can improve students' academic and non-academic achievements [6]. In line with Mulyani's research (2019) that learning with STEM is able to train students to be able to communicate, collaborate, think critically and solve problems as well as creativity and innovation so that students will be able to face global challenges [7].

Based on this background, the purpose of this study was to determine the effectiveness of STEM (*Science, Technology, Engineering, and Mathematics*) integrated learning on the molecular form of the X MIA MA Al-Khoiriyah students.

METHOD

The research design used in this research is descriptive analysis, which is a research design that seeks to describe a symptom of an event or events systematically and accurately and in depth. The research place at MA Al-Khoiriyah with the research subject is class X MIA students in the Even Semester of the 2020/2021 Academic Year. The object of research is the subject of chemistry material Molecular Forms.

The stages of this research consist of 3 (three) stages, namely (a) pre-research which is carried out with the aim of knowing the initial description of the chemical material that is a scourge (which is considered difficult) for most students. This pre-study was conducted by interviewing several MA chemistry teachers who are members of the MGMP KKM 05 Gresik Regency. After knowing the initial description of the pre-research results, a research proposal was prepared and an instrument was developed. Phase (b) test the validation of research tools (syllabus, lesson plans, worksheets, and STEM integrated assessment sheets). The validity test was carried out by 3 experts with expertise in chemistry education. The results showed that the average percentage of the three experts was 92.73 with very high criteria. The results of the validity of learning devices that can be used in this study if they are in the high and very high criteria means that the learning tools can be used in this study. Stage (c) is implementing STEM integrated learning. The purpose of this section is to determine the effectiveness of using STEM integrated learning tools to reduce students' learning difficulties in molecular form material. As for knowing the effectiveness is measured by indicators, namely the level of student learning completeness after integrated STEM learning activities. The instrument used is a written test given after teaching and learning activities and STEM product assessment. The variables in this study were the level of student learning completeness after teaching and learning activities and the resulting STEM products.

The data collection technique is by giving a test (Learning Outcome Test). The initial test is to determine the students' initial ability before implementing STEM integrated learning, while the final test is used to determine the level of student learning completeness. The test is given after KBM using STEM integrated learning. The final test questions used are the same as the initial test questions, so it can be observed how the students' understanding of concepts has changed. Another data collection technique is product assessment. Products are rated by 3 observers using a rubric. The three observers came from chemistry teachers with expertise in chemistry education.

The data analysis technique was carried out by means of the data obtained from the initial test and learning outcomes were entered in the learning outcomes analysis format, then each student was scored with the following conditions:

$$\% \text{ achievement } = \frac{\text{JSDS}}{\text{JST}}\ x\ 100\%$$

Information:

JSDS: Total Scores Achieved by Students

ANN: Total Score

Students are said to have completed their studies if they achieve a value greater than or equal to the KKM. STEM product quality was assessed using a rubric (4=very good, 3=good, 2=poor, 1=very poor).

RESULTS AND DISCUSSION

Before implementing STEM integrated learning, students are first given pre-test questions. The steps taken in STEM integrated learning are (1) Students are brought into the context of problems related to molecular geometry and provide inspiration to students so that they can immediately start investigating/investigating, for example making molecular geometry products from environmentally friendly materials or making use of goods that are environmentally friendly. unused. (2) The teacher provides science learning, students can choose reading, or other methods to collect relevant sources of information. (3) This stage is the teacher bridging the research and information that is known in the preparation of the project. When students begin to learn independently and determine what is still unknown. (4) At the application stage the goal is to test the product/solution in solving the problem. In some cases, students test a product made from the previously defined conditions, the results obtained are used to improve the previous step. (5) The last step is to make a product of molecular geometry. Due to the Covid-19 pandemic, learning is carried out in a limited way in the classroom, so the manufacture of products to the presentation of the resulting product is carried out in their respective homes and videoed. The teacher provides feedback regarding the products produced at the next meeting and gives final test questions to see the completeness of student learning after learning that integrates STEM. The final test is carried out after all the molecular shape learning is completed. The purpose of carrying out the final test is to determine the completeness of the learning outcomes of STEM integrated molecular shapes and also to determine changes in students' conceptual understanding before and after the application of STEM integrated learning. This molecular geometry material is found in KD 3.6 which reads apply the Pair Theory Valence Shell Electron (VSEPR) and Domain theory of electrons in determining the shape of a molecule and KD 4.6 which reads " Making a model of the shape of a molecule" by using ingredients in the surrounding environment or computer software. From KD 3.6 and 4.6, it can be broken down into 3 indicators. Indicator 1: Students are able to identify molecular shapes by applying VSEPR theory and indicator 2: Students are able to identify molecular shapes by applying electron domain theory and indicator 3: Students are able to describe molecular shapes with the materials around them. Initial test scores can be seen in Table 1 as follows.

Table 1. Results of Initial Test Scores

Student's name	Indicator 1						Indicator 2					
	Question Number						Question Number					
	1	2	3	4	5	%	1	2	3	4	5	%
A	1	1	1	0	0	60	1	1	0	0	0	40
B	1	0	0	0	0	20	0	0	0	0	0	0
C	1	1	0	0	0	40	1	1	0	0	0	40
D	0	0	0	0	0	0	0	0	0	0	0	0
E	1	1	1	0	0	60	1	0	0	0	0	20
F	1	1	0	0	0	40	1	0	0	0	0	20
G	1	1	1	0	0	60	1	1	0	0	0	40
H	1	0	1	0	0	40	1	0	0	0	0	20
I	1	1	0	0	0	40	1	1	0	0	0	40
J	0	0	0	0	0	0	0	1	0	0	0	20

From the analysis of the initial test, it can be seen that the ten students who are the subjects of this study have not yet achieved completeness both classically and individually. The results of the final test scores can be seen in Table 2 as follows.

Table 2 Final Test Score Results

Student's name	Indicator 1						Indicator 2					
	Question Number						Question Number					
	1	2	3	4	5	%	1	2	3	4	5	%
A	1	1	1	1	0	8 0	1	1	1	1	1	10 0
B	1	1	1	0	1	8 0	1	1	1	1	0	8 0
C	1	1	1	1	0	8 0	1	1	1	1	1	10 0
D	1	1	1	0	0	6 0	1	1	1	0	0	6 0
E	1	1	1	1	1	10 0	1	1	1	1	0	8 0
F	1	1	1	0	1	8 0	1	1	0	1	1	8 0
G	1	1	1	1	1	10 0	1	1	1	1	1	10 0
H	1	1	1	0	1	8 0	1	1	1	1	0	8 0
I	1	1	1	1	0	8 0	1	1	1	1	1	10 0
J	1	1	0	1	0	6 0	1	1	0	0	0	4 0

From the analysis of the final test, it can be seen that of the ten students who were the research subjects, 80% had achieved completeness. There are two students who have not achieved individual mastery but when compared to the results of the initial test (pretest) these students have experienced a lot of improvement. That is, the difficulties in learning the shape of a molecule can be solved with STEM integrated learning. This is in line with Rahmadhani's research which says that the STEM learning model can significantly improve conceptual mastery of the subjects being taught [8]. In line with research conducted by Mufidah that with STEM learning will be carried out well [9]

The resulting STEM product obtained the following data:

Table 3. STEM Product Rating

Student's name	Score			Average value
	P1	P2	P3	
A	3	4	3	3.3
B	3	4	3	3.3
C	3	4	3	3.3
D	3	4	3	3.3
E	3	4	3	3.3
F	3	4	3	3.3
G	3	3	3	3
H	3	3	3	3
I	3	3	3	3
J	3	3	3	3

From the results of Table 3 it can be concluded that the quality of the STEM products produced in this study is good.

CONCLUSIONS AND SUGGESTIONS

Based on these findings, it can be concluded that the application of STEM (Science, Technology, Engineering, and Mathematics) integrated learning on the material of molecular form for Class X MIA MA Al-Khoiriyah students can be said to be effective (80% of students achieve mastery learning and the products produced in the category good) .

With this research, it is hoped that it can be an alternative to chemistry learning, especially abstract material

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