

# A Preliminary Study on STEM Encouragement in Chemistry Subject: The Learning Experience of SMK Usukan Students in STEM AUMS Warrior Program

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**ABSTRACT** Currently, due to the lack of awareness in STEM education, the number of Science, Technology, Engineering and Mathematics (STEM) students in Sabah has been continuously decreasing. It is crucial to engage school in rural area of Sabah with STEM activities to boost their interest towards STEM education. The primary goal of this study is to establish effective Chemistry-STEM module, analyzing the preliminary effects of the integration on the interest of students, and encouraging STEM education to rural students through chemistry subject. Present study is the preliminary investigation on the learning experience of students in STEM through the Chemistry module. For the purpose of this study, a sample of 74 students from the lower secondary school of SMK Usukan, Kota Belud, Sabah participated in The Power of Atom Module developed by Preparatory Centre for Science & Technology (PPST), Universiti Malaysia Sabah (UMS). Student's learning experience data was gathered through a questionnaire that results in statistically significant improvement in STEM learning and communication skills. The findings suggested that the Chemistry-STEM module developed by Chemistry lectures encourage and enhance self-learning, interest in learning Science (i.e. Chemistry), teamwork skills and communications skills of the students. It shows that this module is approachable to rural schools in learning STEM education.

**KEYWORDS:** STEM Education; Chemistry STEM Module; Rural Area Students; Secondary School; Sabah

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## INTRODUCTION

Science, technology, engineering, and mathematics (STEM) is a branch of learning that needs to be emphasized in leading the life in 21st century. The Ministry of Education Malaysia had launched Malaysian Education Blueprint (PPPM) 2013-2025 by placing STEM education as an important educational transformation. The STEM education is now in the Second Wave phase where campaigns and collaborations with relevant bodies are implemented to attract the interest and awareness of the community in STEM.

Many studies have been conducted related to STEM education in Malaysia. However, most of the research was focused on the one that delivers STEM education. Ismail *et al.* (2019) and Adam and Halim (2019) reported the challenges in integrating STEM education in Malaysia. Lack of facilities and support from school leaders as well as teachers' experience and exposure on STEM are among the issues faced in empowering STEM education. The same results were also reported by Ramli and Talib (2017) where these problems can be a barrier in implementing STEM education effectively.

There is a lack of documented research established in reporting the effectiveness of integrating STEM education on the students' performances (Jayarajah *et al.*, 2014). Chong (2019) says that Malaysia has established necessary interventions in implementing STEM education, however its

effectiveness is still unknown. It is suggested that more quantitative studies should be done to prove the effect of integrating STEM education throughout every level in Malaysia's education system.

On the other hand, some researchers had used some methods to stimulate the STEM teaching and learning process. Ng and Adnan (2018) implemented the STEM modules in mathematics among year one pupils through Project-based Inquiry Learning (PIL). This method encourages students to understand more on mathematical concepts through projects as well as boost the confidence among teachers to carry out STEM education in school. 5E (engage, explore, explain, elaboration and evaluation) Instructional Model lesson plan was used by the study conducted by Ahmad *et al.* (2018). This study states that the implementation of STEM education using this model helps create a creative teaching and learning process in chemistry subjects.

In 2019, The Energy, Science, Technology, Environment and Climate Change Ministry (MESTECC) reported a declining trend in students enrolling in STEM subjects or courses in schools and higher education institutions (IPT). This decline in numbers caused by the students prefer to choose a much easier course besides, lack of awareness in importance of science in their lives (Bernama, 2019). In order to facilitate the integration of STEM education among the students, Preparatory Centre for Science & Technology (PPST), Universiti Malaysia Sabah has established a program in collaboration with one of the schools in Sabah in line with the second wave phase of the PPPM 2013-2025.

STEM AUMS Warrior Program is one of the activities led by PPST to support the STEM movement. PPST in collaboration with SMK Usukan Kota Belud Sabah had conducted this program by targeting a group of students from lower secondary school of SMK Usukan to participate. The STEM teaching and learning approach is used where it involves the STEM knowledge, skills, and values application by the students to solve problems through the projects provided by PPST. This program is similar to the study conducted by Ng and Adnan (2018). This approach encourages the students to ask and explore through inquiries, application and problem solving related to the real world. As suggested by BPK (2016), this approach can lead to enculturation of STEM practices.

## METHODOLOGY

### *Research Design and Sample*

In this study, the sample was taken from SMK Usukan, Kota Belud, Sabah that considered rural school located around 60 KM away from Kota Kinabalu, Sabah. A sample of 74 students at lower secondary schools' students (form 1 and form 2) participated in this research. Prior to the implementation, students were divided into 4 number of group and each of this group will be provided with facilitator to guide them throughout this module. This Chemistry-STEM module was conducted by the lecturers using a friendly approach namely "The Power of Atom" module. The main idea of this module is to engage and attract interest among students towards chemistry. The design of this module activity is related to the importance of chemistry in everyday life.

Simple chemistry experiments were carried out for 3 hours session. All groups were given identical materials to run an activity of determine the density various solid and liquid, solubility of water, making ice-cream using normal table salt, word search, and produce an environmental poster. Throughout the session, students were encouraged to ask questions, make connections of the problem with the surrounding and make suggestion for improvements. Finally, the implementation

ended with students answering the questionnaire. This study used a quantitative approach and adopted pre-experimental one group post-test design.

#### Data Collection Instrumentation

To determine the extent of effectiveness of Chemistry STEM Module in improved learning and communication skills among students, a questionnaire that was constructed according to Luo *et al.* (2017) is distributed among participants at the end of the module. There are nine questions in total with 6-points of Likert Scale as illustrated in Table 1 where SD, D, MD, MA, A and SA are strongly disagree (1), disagree (2), moderately disagree (3), moderately agree (4), agree (5) and strongly agree (6), respectively. This questionnaire was formed and validated by an English teacher before distributing to students.

**Table 1.** Questionnaire of Chemistry STEM Module.

No	Statement	SD 1	D 2	MD 3	MA 4	A 5	SA 6
Q1	The interaction between warrior and students was active	1	2	3	4	5	6
Q2	The warrior offered discussion opportunity	1	2	3	4	5	6
Q3	This module improves my learning effectively	1	2	3	4	5	6
Q4	This module motivated me to learn	1	2	3	4	5	6
Q5	This module sharpens my expression and communication skills	1	2	3	4	5	6
Q6	This module enhanced my confidence in speaking public	1	2	3	4	5	6
Q7	This module developed my self-directed learning skill	1	2	3	4	5	6
Q8	This module enhanced and interaction and collaboration skills	1	2	3	4	5	6
Q9	This module increases my interest on science knowledge	1	2	3	4	5	6

#### Data Analysis

A statistical software package, SPSS version 24.0, was used to analyze the data from questionnaire to produce descriptive statistics. To analyze the effectiveness of Chemistry STEM Module in terms of encouraging learning and communication skills, both frequency distribution and descriptive statistics are evaluated.

## RESULT AND DISCUSSION

The result of the study shows that students view positively towards the learning approach of Chemistry-STEM Module in terms of their learning and communication skills. Table 2 shows frequency distribution for effectiveness in learning and communication for Chemistry. 62.2% of students answered that the module is very effective in improving learning and motivation. 36.5% of students felt that the module is effective. Meanwhile, only 1.4 % of students claimed that the module is somewhat effective. Table 3 illustrates the effectiveness of communication and teamwork where 60.8% of the students answered that the module is very effective. 33.8% of the students felt that the

module is effective in improving communication and teamwork. Only 5.4% of the students claimed that the module is somewhat effective.

**Table 2.** Frequency Distribution for Effectiveness in Learning Towards Chemistry STEM Module

Valid	Frequency	Percent	Valid Percent	Cumulative Percent
3.50 – 4.49	1	1.4	1.4	1.4
4.50 – 5.49	27	36.5	36.5	37.8
5.50+	46	62.2	62.2	100.0
<b>Total</b>	<b>74</b>	<b>100.0</b>	<b>100.0</b>	

**Table 3.** Frequency Distribution for Effectiveness in Communication Skills Towards Chemistry STEM Module

Valid	Frequency	Percent	Valid Percent	Cumulative Percent
3.5 – 4.49	4	5.4	5.4	5.4
4.50 – 5.49	25	33.8	33.8	39.2
5.50+	45	60.8	60.8	100.0
<b>Total</b>	<b>74</b>	<b>100.0</b>	<b>100.0</b>	

With reference to Table 4, the data analysis of descriptive statistics for both learning efficiency and communication skills toward the Chemistry-STEM module demonstrate that the learning mean scores which are 5.46 marginally lower than the communication scores which are 5.50. However, both show good results in effectiveness. Both learning and communication are negatively skewed with respect to the distribution of attributes, which means that both distributions appear to have outliers below average. In the meantime, the distribution for learning effectiveness is platykurtic, while the distribution for communication effectiveness is leptokurtic. The difference in kurtosis is because less people have chosen “somewhat agree” for communication effectiveness and appear to become outlier, leading to positive kurtosis.

**Table 4.** Descriptive Statistics for Effectiveness in Learning and Communication Skills Towards Chemistry STEM Module

	N	Mean	Std. Deviation	Skewness		Kurtosis	
				Statistic	Std. Error	Statistic	Std. Error
Learning	74	5.4696	.45884	-.499	.279	-.644	.552
Communication	74	5.5095	.52720	-1.289	.279	1.592	.552
Valid N (listwise)	74						

Findings from this research indicates that the subject of Chemistry affects the interest of student in STEM. The excitement generated by offering students the chance to practically learn basic chemistry hands-on instead of conventional reading methods or lectures. Students can examine phenomena, draw conclusions, and exercise scientific skills in the handling of devices through practical work, which contributes to meaningful science learning and the development of critical thinking skills (Yakar & Bayakar, 2014). This is because simply understanding how to exploit theoretically will not help students learn manipulative skills and scientific concepts, as Campbell (2002) argues that learning science is best accomplished by conducting experiments and developing concept in the laboratory first-hand, rather than by reading hypotheses. While Anderson (1982) stressed the importance of practice to turn information into procedural form as a medium. Student that lack of hands-on activities exposure could lead to the lack of acquisition of manipulative skills. This is supported by Siew *et al.* (2016) which stated that student could look for connection by

engaging with activities or material in 'real-world' contexts to establish relevance. This strategy will draw the interest of students in science lessons and give them a comprehensive understanding of concepts and practical learning.

Guiding the student to perform basic experiments, providing them with new information and insight about how science works, seems to be correct formula to teach the student how Chemistry would theoretically be a great subject of science to study. According to Chong (2019), by gaining scientific knowledge and scientific reasoning abilities, science education helps to establish scientific literature for learners so that they can obtain a greater understanding of how things function in the natural world.

Although this preliminary research showed that there is significant interest among the students in learning STEM education through chemistry subject, more hands-on activities with longer duration of program needed to be conducted in the future to support this study. More parallel programmes with different STEM education-related studies are suggested to be performed at a very early level, such as primary school, to seed the interest of younger generations in STEM education. This serves as an early insight into the fascinating aspect of STEM education for the younger students, and also helps steer their education path towards Science Stream in secondary school (Fadzil & Saat, 2014; Galton *et al.*, 2003; Hawk & Hill, 2004).

## CONCLUSION

This study is ongoing project with goals of encouraging students to pursue their future education journey in STEM Module for SPM during upper secondary school. Hence, this preliminary result concludes that for both educator and students, the proposed program is a highly and influential teaching and learning process. Chemistry can theoretically become the primary reason why students would want to pursue STEM in the next stage of their study as one of STEM's fundamental subjects. In the case of SMK Usukan, most students can be seen eagerly participating in each experiment performed with the facilitator's guidance. Even with some challenges in running the experiment, it has become eye opener experiences for the student on how application of science knowledge can solve daily life problems, particularly using Chemistry knowledge. The STEM AUMS Warrior program shows that STEM still has its spark, but much more efforts and similar program to be done to raise STEM's interest among student in Malaysia, especially in Sabah.

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