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STEM@HOME MODULE FOR A SUSTAINABLE VIRTUAL STEM MENTORING DURING LOCKDOWN SCHOOLING

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Abstract

The STEM outreach program is important in fostering the interest of students to pursue the STEM field as well as facilitating them in developing their STEM skills. The rise of COVID-19 pandemic in 2019 has forced lockdown schooling in most affected countries. Thus, there is a demand for a home-restricted STEM module to facilitate STEM education both online and offline. The STEM@Home module has been designed by the university lecturers to assist lockdown schooling and a case study has been conducted to measure its effectiveness as a STEM outreach module. In this study, 140 students from 2 secondary schools in Kuala Selangor, Malaysia have been selected as mentees and 28 university students from Universiti Selangor played role as mentors. The mentor guided the mentee virtually using the online platform to facilitate the mentee in conducting the module at home. Mentors were instructed to record their observation and answered a survey after every session to monitor the progress of both mentors and mentees. Based on this study, the module received positive feedback from mentors, mentees and teachers. There was also a significant improvement recorded on the STEM skills portrayed by both mentors and mentees. This finding is beneficial to the government, universities and schools as the results portray the strength of this module and sustainable approach. Similar programs could be implemented in other schools and this study could provide relevant input in strategizing future outreach programs for a higher quality education in line with goal 4 in the Sustainable Development Goals (SDG).

Keywords: COVID-19, lockdown schooling, mentoring, STEM at home module, STEM outreach

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1. Introduction

Science, Technology, Engineering and Mathematics (STEM), is an important field that contributes to the development and sustainment of the economy of a country as it promotes problems and logical thinking skills and applies creativity and innovation capability. STEM is more than just a body of knowledge to be acquired and comprehended; it is also a potent approach for recognising and addressing issues, with a strong creative component. Students gain significant knowledge by comprehending the knowledge, fostering the interest of students that prepares them to pursue in the STEM field as well as facilitating them in developing their STEM skills. Therefore, awareness of the importance of this field is very important for building the necessary skills in each individual but not easy and requires effective methods.

The STEM Outreach approach has been approved in increasing student interest in STEM fields by implementing fun learning activities that support teachers, and attracting public and student awareness (Azman et al., 2021a; Ab Hamid et al., 2021; Fauzai et al., 2021). Students' intrinsic enthusiasm for science and scientific learning might benefit from the outreach efforts which may affect the community perceptions and attitudes toward STEM (Nawawi et al., 2021). STEM outreach programs require an appropriate approach so that students can gain a sense of relevance and discover new potential through live presentations or experiments that relate knowledge learned from textbooks to applications in everyday life and the real world (Margot & Kettler, 2019). Thus, the live demonstration method is the best method to understand STEM knowledge that has been applied in various STEM outreach programs. Study has shown that this approach increases interest and triggers curiosity in the applied science field (Moid et al., 2021). However, it is quite difficult to apply and implement such an approach in the current pandemic situation.

1.1. Impact of STEM Outreach during COVID-19

Due to the recent COVID-19 outbreak, schools were forced to close their doors, disrupting both formal and informal education. Planned STEM outreach programmes must be adapted to accommodate the "new normal" (Ufnar et al., 2021). The COVID-19 pandemic has had a profound impact on the lives and learning experiences of all students. Students faced difficulties accessing the resources provided by their academic institutions, including academic support programmes, technology labs, consistent internet connection, health services, and on-campus or school jobs, as campuses or schools closed and transitioned to online and hybrid learning experiences. For example, the need for support around foundational STEM concepts where, due to remote learning, students may have developed more fragile and weak understanding. At this crucial moment, there is a strong desire and anticipation for more personalised support.

The partnership between STEM experts at universities and informal STEM education institutions is an important collaboration that has evolved over the past several decades. Hundreds of these collaborations have established innovative and highly effective approaches to improving teacher STEM content and confidence in STEM teaching; increasing student achievement in STEM areas; and increasing student excitement about STEM and interest in pursuing STEM careers (Appel et al., 2020; Azman et al.,

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2019; Sadler et al., 2018). As the pandemic spread and educational institutions were closed, these collaborations were suddenly faced with the challenge of maintaining their connections with students.

2. Problem Statement

Although the technology was available, the move to fully integrate online teaching and learning was a slow endeavour, which is inconsistent across all academic disciplines, particularly in the STEM area. Unpredictably, COVID-19 provided a strong push to accelerate knowledge transfer and skill development through e-learning platforms since almost all activities were conducted remotely (Thanawala et al., 2021). The physical presence of students and teachers in school was strongly discouraged and as the severity and the duration of the pandemic exceeded the initial assumptions, the need to keep students and teachers engaged in the virtual teaching and learning of STEM is of great demand (Ufnar et al., 2021). Thus, STEM@Home was designed in order to facilitate STEM outreach during lockdown schooling.

3. Research Questions

The following questions guide this study:

- What is the impact of this STEM@Home module to the mentor, mentee and teachers?
- How effective is this module conducted virtually?

4. Purpose of the Study

The present study attempted the use of the STEM@Home module to engage students and teachers in STEM learning using materials that can be found easily at home. In addition, pre- and post-tests were also carried out to examine the effectiveness of the STEM@Home module virtually.

5. Research Methods

5.1. Sample of study

This study was conducted during the lockdown schooling period of 2021 involving students from SMK Rantau Panjang and SMK Tiram Jaya, both located in Kuala Selangor, Selangor, Malaysia. 70 students from each of these schools participated as mentees while 28 students of Universiti Selangor played role as mentors. The outreach activities were conducted with a minimum of five virtual interactions.

5.2. Module

The STEM@Home module was developed by lecturers of Universiti Selangor. The module consisted of five submodules namely STEMtani, Easy Math, STEM Soap, DIY DNA and STEM Kitchen. STEMtani introduced fundamental concepts of fertiliser by teaching mentees to make their own

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biocompost and biochar and experimenting with them by growing bean sprout seeds. Meanwhile, STEM Soap activity was introduced to expose mentees how to make homemade soap using simple procedures and waste cooking oil. Whereas in the DIY DNA submodule, mentees learned how to extract DNA from fruits using ingredients obtainable at home.

On the other hand, Easy Math guides mentees in learning about shape and polygon, area and volume, as well as angle and trigonometry from the comfort of their home. Lastly, STEM Kitchen was conducted with three different activities, the first one was Why You Wash Your Hand. This module exposed the mentees how microorganisms grow on the food source in the kitchen. Second activity was the reaction of dried fruit after mixing with several ingredients and causing a chain reaction by carbon dioxide, namely Dancing Dried Fruit. Finally, mentees were introduced to prepare Aiskrim Malaysia based on density and buoyancy principle to produce colourful ice cream.

5.3. Data Collection

Two different surveys were distributed in the beginning of the program (pre-test) and after both mentors and mentees have completed the STEM@Home module (post-test). The first survey was the evaluation of mentee STEM skills by the mentor. These five STEM skills include knowledge, teamwork, problem solving, critical thinking and communication skills. Mentors were required to monitor their mentees achievement on these skills based on the six cognitive bloom taxonomy classification. Mentors assessed their mentees skills based on the answers given on the distributed questionnaires along with the verbal information and observation gathered throughout the programs.

The second survey was aimed for the mentor to reflect their own development throughout the program. There were 28 questions in a form of seven-Likert scale with score 1 for the strongly disagree and score 7 for the strongly agree. These questions were sectioned into respective skills: communication, innovation, teamwork, knowledge application, competency. integrity, lifelong learning and systematic approach.

The survey questions were outlined based on the research objectives. The survey was analysed using the Statistical Package for the Social Sciences (SPSS), with tabulated data organised by section and presented in a table. Observation and interviews with students and teachers were also used as data collection tools.

6. Findings

6.1. Mentees

There are five main skills tested for mentees namely knowledge, team work skills, problem solving skills, critical thinking skills and communication skills. These tests involved pre- and post-tests for both mentees from SMK Rantau Panjang and SMK Tiram Jaya. The scale used for this test is based on Bloom Taxonomy cognitive level where the score rank is from 1 to 6.

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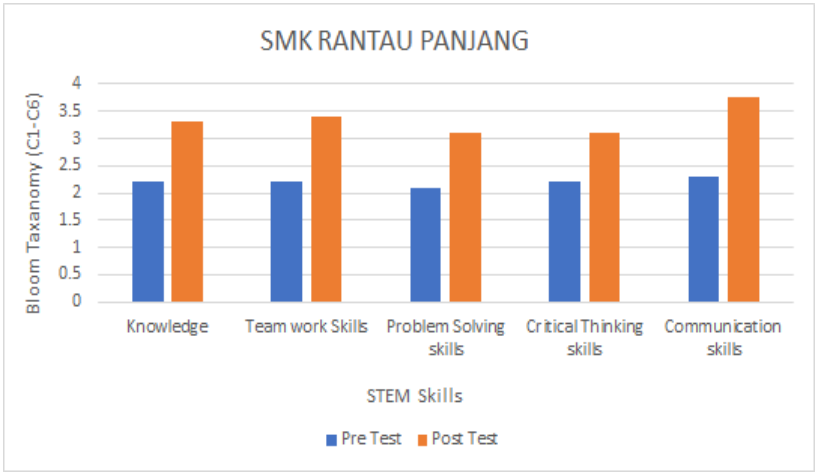
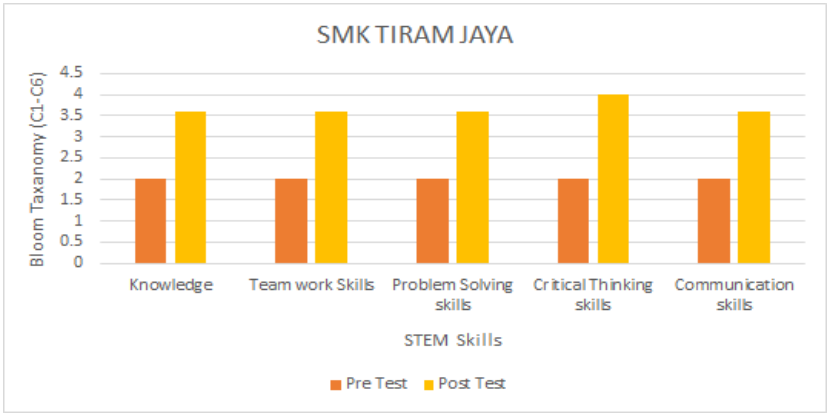


(a)



(b)

Figure 1. Result of pre- and post-test mean score on STEM skills demonstrated by mentees in (a) SMK Rantau Panjang and (b) SMK Tiram Jaya

Based on Figure 1, the mean score for all skills increased after the mentees took part in the module sessions. The most improved skill for SMK Rantau Panjang is communication skills where the mean score for pre-test is 2.3 and it increased to 3.7 for post-test compared to other skills. The mentoring approach, albeit virtually, encouraged mentees to voice their thoughts and curiosities. The post-test also affirms that with improved communication skills, students feel that they perform better in team work, proven by the increase in mean score from 2.2 (pre-test) to 3.4 (post-test).

Similar to the other school, SMK Tiram Jaya displays an overall improvement in all skill sets with the highest seen in critical thinking skills. The mean score for pre-tests is 2 and the value doubled for post-test, the mean score linearly increases for other skill sets. This result is in agreement with similar mentoring STEM outreach programs conducted by using different modules (Azman et al., 2021b; Baharuddin & Baroud, 2021; Halim et al., 2018) thus suggesting that mentoring approach is effective in fostering scientific enquiry skills. Results also confirmed that the module aids in development and skill enhancement among mentees from both schools at home. This result is consistent with a recent study which developed a STEM project that can be conducted at home virtually. The study found that students are willing to conduct simple STEM projects at home (Zulirfan et al., 2020).

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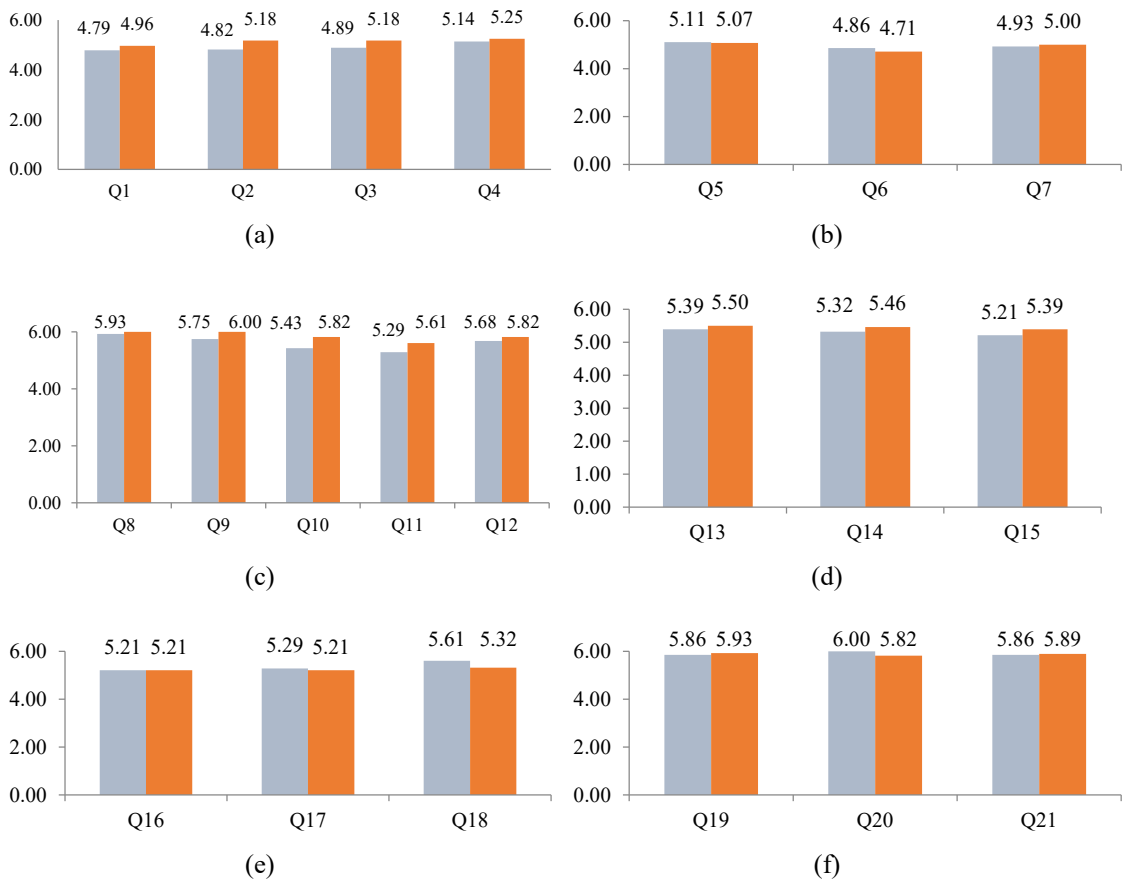
6.2. Mentors

Based on Figure 2, section a, c, d and g show the mean score for each skill increased post-test with section b, e, f and h observing a decrease trend of mean score. The result indicates that mentors agreed that through these programs their communication skill, personality and team work, ability to use knowledge in solving problems and their life-long learning has been improved. Since the program was conducted online, the mentoring task was more challenging in order to solve the problems faced by mentees. This result is in line with previous studies which used a mentoring approach in STEM outreach (Azman et al., 2021b; Brown et al., 2021; Hassan et al., 2021).

Whereas section b, e, f and h shows the mean score for each skill decreased after the mentors took part in the module sessions. The result indicates that some mentors demonstrated the lack of confidence with their competence in terms of applying their knowledge of innovation and competence in a particular field. One potential reason is that some mentors were inexperienced in the STEM outreach program. They need guidance from their senior mentor in terms of professional, social and ethical responsibilities and the ability to use systematics approaches in mentoring. Another possible reason for the decreasing result could be due to the challenge of conducting virtual activity as suggested by recent study (Ufnar et al., 2021).



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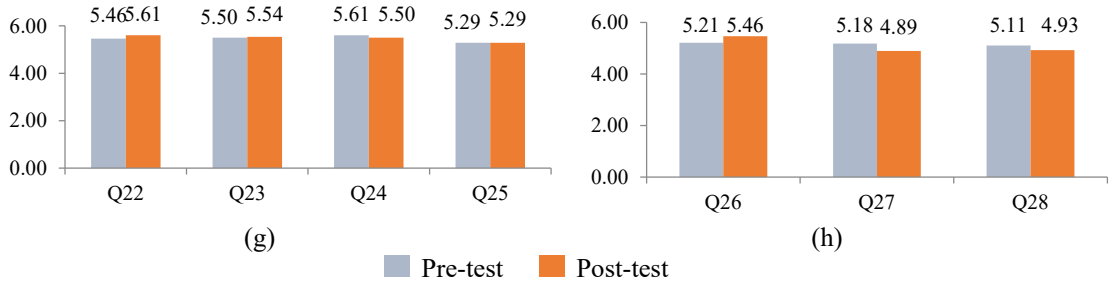

Figure 2. The difference mean score for pre-test and post-test for mentors in (a) the ability to communicate effectively; (b) competence in applying and using knowledge of innovation; (c) personality and team work; (d) applying the knowledge in solving problem; (e) competence in a particular field; (f) understand the professional, social and ethical responsibilities; (g) life-long learning; and (h) the ability to use systematic approach.

6.3. Teachers

Towards the end of the program, feedback was gathered from teachers of both schools. All of the feedback was positive as they supported the program. One feedback highlighted the eagerness of their students in conducting the module with active participation observed in general throughout the session. Another feedback mentioned poor internet connectivity as the challenge faced by some respondents throughout the session as these students reside in rural areas such as rubber estate and oil palm plantation. Recent study highlighted the challenge of teachers in providing virtual instruction for STEM courses (Dhurumraj et al., 2020). Poor connectivity may contribute to such a challenge and this is something that should be considered to improve the module by ensuring that the module is self-explanatory for targeted learners. It is also noteworthy to mention a feedback which conveyed the appreciation of a district educational officer upon her random observation during one of the online sessions. All of these feedback indicated strong support by relevant stakeholders especially teachers on the module and virtual mentoring session.

7. Conclusion

The STEM@Home module was designed and executed as a STEM outreach module in assisting STEM education during lockdown schooling by introducing five interactive activities. All the activities successfully draw the attention and interest of all the students involved. Students gained considerable procedural skills in these programmes in new norms through hands-on experiments using materials at home via online live demonstration to discuss current emerging science topics. Overview of the outcome, this module successfully keeps students motivated to learn STEM and aids in development and skill enhancement in the STEM field. Communication skills found as the increased skills enhancement over five skills tested. The post-test survey affirms that improved communication skills help students to perform better especially in team work activity.

The main challenge in making the STEM@Home modules effective is understanding how it can be carried out in schools and homes with limited or unstable internet connectivity. In order to do so, the modules were run in series, this not only maximises understanding on each module it also reduces the internet data consumption compared to a long session. Secondly, the modules' concise and easy-to-follow

instructions, with brief explanation of the procedures, facilitates the mentees to carry out the modules with ease. The modules were meticulously revised and amended with every testing and feedback received from participating schools to ensure its effectiveness for future usage.

As a conclusion, a home-restricted module called STEM@Home module which encompasses all the STEM education elements conducted during COVID-19 pandemic able to nurture students' scientific enquiry skills and stimulate creative ways to solve problems with current challenges. The study conducted successfully showed a positive impact on students' level of communication skills and increased students' confidence level in making decisions.

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