

Introducing and Increasing Interest Towards STEM Through Service Learning; Informal Learning and Soft-Skills Challenge

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ABSTRACT

STEM @KERAKED, a service-learning program, aimed to introduce and develop their interest in STEM (Science, Technology, Engineering, and Mathematics) at a very young age through informal science learning. Kids at the age of seven to twelve that live in Ayer Baloi, Pontian, Johor participated were divided into small groups and provided with two facilitators, university students, which led them throughout the explorer-like program. This explores had four elements of STEM separated into checkpoints, which had demonstrations and games, and finally related to daily lives and natural phenomena. There were pre- and post- questionnaire for the participants, comparing and investigating their understanding and perception towards STEM. Based on the analysis of the questionnaire, there are improvements in the knowledge of STEM for most of the participants. Besides, the other improved element that can be seen is their teamwork and also their interest in working in a team for this particular type of activity. Not only this program benefits the participants, but this program also gave a lot of beneficial experience to the facilitators and crews, in term of having a platform to apply their STEM knowledge and challenging their soft-skills. This paper shows the benefit of informal science learning to both participants and facilitators.

Keywords: Service Learning, STEM, Teamwork

1. INTRODUCTION

Dr. Mahathir Mohamad has outlined nine strategic challenges that Malaysia must overcome to achieve Vision 2020, and one of them is establishing a scientific and progressive society. This highlighted the importance of science in the community of the country. Based on the national science and technology enrollment policy, the government has targeted the ratio of 60:40 for the scientific literature field area. To achieve that ratio, many activities have been carried out to increase awareness regarding the importance of STEM for the competitiveness of our country. One of the strategic efforts to improve this awareness is the service-learning that is usually conducted by universities to give the chance of knowledge transfer between the university students with the community. In primary and secondary school, most of the learning process is based on theoretical learning in which most of the time, the students cannot relate the real-world application of the things that they learn. Hence, service-learning regarding STEM is an excellent channel to expose students to the

activity-based learning for better understanding and visualization of the theories that they learn in school. This measure is taken to prepare Malaysia towards Industrial Revolution 4.0 (IR 4.0), where the industries promote automation that is closely related to science and technology. This paper will discuss how activity-based learning is conducted to promote interest towards STEM among students and improved their understanding of STEM in a fun and interactive way.

2. PROBLEM BACKGROUND AND LITERATURE REVIEW

High School Planning Committee 1967 have set to improve the enrollment ratio for students in the science and technology field to literature field from 45:55 in 1970 to 60:40 starting from the year 1980. To achieve that ratio, many initiatives and efforts have been made by the government to attract the interest of students to enroll in the science and technology field. Ministry of Education through

Pelan Pembangunan Pendidikan Malaysia (PPPM) for the term of 2013 to 2025 have planned various strategies to strengthen the subjects that are based on science, technology, engineering, and mathematics (STEM) by implementing new approaches such as strengthen and improvise the curriculum and combining them with high critical thinking skills. One of the efforts towards producing citizens with high scientific and innovative skills is through the establishment of Maktab Rendah Sains Mara (MRSM) and also other science schools that focus on exposing their students with the science stream. This approach has significantly increased the number of students that enroll in the science and technology field, matching with the requirement of government to develop a country that meets the ratio of 60:40 for science to the literature field. In the year of 2010, the ratio of science literature is 48:52, which is still far away from the targeted ratio.

Meanwhile, in the year 2014, the progress decrease to 47:53, with only 29% of form 5 students enroll in the science stream. According to Laporan Akademi Sains Malaysia (ASM), in 2015, only 21% of students that sit for Penilaian Menengah Rendah (PMR) are eligible to enter the science stream in 2014. If there is no action taken, the probability of that percentage to continue decreasing is high.

For over 50 years, the primary goals still cannot be achieved even though many initiatives had been taken to increase the percentage of Malaysians that involves in the science and technology field. In a matter of time, the era of automation will hit the industry, where the knowledge of science and technology is essential for a country to compete with others. That is the main reason for the government to attract more people to jump into this area. Science and technology play an essential role in keeping Malaysia on the same level as other developed countries through the activity of research, urban development, and technical sophistication. Thus, the quality of education in Malaysia needs to be reviewed to improve the quality of graduates that comes from local universities. This is because university institutes play a significant role in developing their students according to the needs of the country. The programs that they offer must be suitable for the country's markets to aid the development of our country and also improves the marketability of their graduates. The quality of their education will also be the image of the institute and even the nation.

STEM approach on the institution-level has been widely implemented in developed countries such as the United States. This is because most of the future jobs are related to STEM. This can be proved by looking at the United States of America, where 80% of the jobs are related to STEM. Other examples of developed countries that stress the elements of STEM are Singapore and the United Kingdom,

where STEM is implemented on various levels such as school, industry, and government.

In STEM @ KERAKED, we provided the chance for primary school students to improve their understanding of science, technology, engineering, and mathematics through activity-based learning in groups, which requires them to interact with group members to complete the tasks given while increasing their interest in this field. This aspect can also dramatically improves the participant's teamwork and communication skills, which is a vital trait that needs to be mastered by every student in Malaysia. Through this program, participants need to implement critical thinking skills to solve the problems. Activity-based learning is an approach where students obtain knowledge based on what they do. Usually, they only learn based on theories in school, so it is quite challenging for them to remember everything because of the limitation to imagine the things that they know. Through activity-based learning, they learn something by doing it themselves; hence the learning process is more efficient.

This type of learning process is also known as experience-based learning, which is a well-known model in education. Kolb's Experiential Learning Theory (Kolb, 1984) defines experiential learning as "the process whereby knowledge is created through the transformation of experience. Knowledge results from the combination of grasping and transforming experience." Kolb's Experiential Learning Theory presents a cycle of four elements:

1. Concrete Experience
2. Reflective Observation
3. Abstract Conceptualization
4. Active Experimentation

The cycle begins with a substantial experience that the students had based on what they did or saw, followed by the opportunity to make a reflective observation of what they experienced. Next, the students may conceptualize and draw conclusions based on the experience and observation, leading to future actions in which the students experiment with different behaviors.

3. STEM @ KERAKED

As many as 22 students of Universiti Teknologi Malaysia (UTM), consists of two different parties, 11 crews from Kolej Tun Razak (KTR) and another 11 crews from the Science and Community course, which we're doing their undergraduate studies in Faculty of Science and Faculty of Engineering, collaborated in conducting a program of Science, Technology, Engineering and Mathematics (STEM) named STEM @ KERAKED for the community

of Ayer Baloi, Pontian, Johor. KERAKED stands for Kembara Razak Ke Desa, which is the annual KTR’s community service. This program was held at Dewan Haji Sidek Pt. Keroma, Ayer Baloi, Pontian, Johor, and was organized by Science and Community course, UTM, in collaboration with Jawatankuasa Mahasiswa Kolej, KTR on 30 March 2019. It involves 19 students as participants from various schools around Ayer Baloi, gathered together to join a 5 hours program. The best part of the program is figuring the community of Ayer Baloi, of which some of them do not know each other before even though they live in the same neighborhood, hence this program helps to create bonding between them even though they are from different schools.

The main objective of the program is to expose the students with STEM besides attracting their interest in STEM at an early age. The program conducted is based on informal science learning in which the students are divided into small groups to ensure each one of them gets the maximum input from the activities.

3.1 Ice Breaking and Briefing

The purpose of the ice-breaking session was to provide a comfortable environment before the program starts. This was important for facilitators so that they know how to treat different types of participants’ personalities. Next, the participants were divided into four groups, and each group was provided with two facilitators. After having their cheers to create excitement, they needed to answer a questionnaire, a pre-test.



Figure 1. Participants sitting in the group

After introducing STEM to the participants, the facilitator briefed about the four checkpoints representing science, technology, engineering, and mathematics. They were focusing on these four elements’ differences and how they relate to each other. Each group was given 20 minutes to finish their tasks for each checkpoint, including the trial and evaluation. For every individual involvement, such as answering questions, stars were given as awards.

3.2 Science – Mini Volcano

For the science checkpoint, the activity that has been chosen is a mini volcano. In this activity, the provided items were food coloring, baking soda, vinegar, plasticine, a plastic cup, and a container for the base of their mini volcano. Through this activity, the participants were introduced to the chemical reaction between vinegar and baking soda that creates a gas called carbon dioxide. While the participants were making their mini volcano, the facilitator at that checkpoint asked them several questions to ensure that they understand the concept of science in the mini volcano activity. At this checkpoint, the evaluation criteria include the time they used to finish the model, their creativity, teamwork, and accuracy of technical discussion.



Figure 2. Participants making the mini volcano

3.3 Technology – Cork Launcher

For the technology checkpoint, the activity that has been chosen was cork launcher. The provided items at the checkpoint were ice cream sticks, chopsticks, rubber band, bottle cap, glue, glove, and a clothespin. The participants were required to create a model of a cork launcher that implements the concept of strength and elasticity. Similar to the previous checkpoint, the facilitator asked several questions while they were building their model to help them understand better. At this checkpoint, the evaluation criteria include the time consumed, strength, distance of cork launched and creativity.



Figure 3. Participants building a cork launcher



3.4 Engineering - Catapult

For the engineering checkpoint, the activity that has been chosen was the catapult. The items provided at the checkpoint were ice cream sticks, glue, chopsticks, bottle cap, rubber band, sellotape, and glove. The participants were required to create a model of a catapult launcher that implements engineering concepts such as stability, strength, and elasticity. All of the checkpoints implement the approach of learning by asking for a better understanding of the activity. At this checkpoint, the evaluation criteria includes the time consumed, strength, number of goals and creativity.





Figure 4. Participants building a catapult

3.5 Mathematics – Mathematical Operations Challenge

For mathematics checkpoint, the activity that have been chosen was *make it zero*. In this activity, the participants were required to create as much arrangements as possible as long as the output of the mathematical operations become zero. This checkpoint stressed the concept of BODMAS, which is the acronym and stands for Bracket, Of, Division, Multiplication, Addition and Substraction in calculation. At this checkpoint, the evaluation criteria includes the number of arrangements successfully made and teamwork.



Figure 5. Facilitators of mathematics checkpoint

3.6 Closing and Award Ceremony

After they have finished all of the checkpoints, the facilitators summed the marks obtained from every checkpoint for each group. The winner was chosen based on the highest marks. Before the prize presentation ceremony, the facilitators invite some representatives of the participants to share their feelings and lessons learned from this explorer-like informal science learning. One of them

successfully pointed to every single aspect that she learned from each checkpoint, as prepared by the facilitators. Next, the facilitators summarized, motivating all participants to explore STEM more in the future. Finally, the participants filled the feedback form, the post-test, required for this paper’s analysis. There were several categories of prizes, such as team prizes and also individual prizes based on the total of stars that they collected throughout the program.



Figure 6. Prize presentation ceremony

3.7 Facilitators Experience

The feedback and reflection of the facilitators were also studied. Two main aspects will be discussed in this paper, which is the communication skills challenge and service-learning experience. Table 1 shows the items included in the feedback form.

Table 1. Feedback Form for Facilitators of STEM @KERAKED

Aspects	Items
Communication Skills	<ol style="list-style-type: none"> 1. I learn to communicate instructions better throughout this program. 2. I feel that I am improved in my public speaking skills. 3. I have learned how to handle miscommunication better. 4. Participating in this program allow me to practice my communication skill.
Service Learning Importance	<ol style="list-style-type: none"> 1. University students need to be familiar with community service 2. Community service helps university students to be holistic persons 3. I will encourage my friends to participate in community services during their study actively 4. Service-learning plays an essential

	<p>role in my research at the university</p> <ol style="list-style-type: none"> 5. Skills practiced while organizing and participating service-learning can be applied in future 6. I gained experience through this service-learning program as I hoped at the beginning of this semester
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4. RESULTS AND FINDINGS

Table 2. Pre- and Post- Questionnaire for Participants

Aspects	Before	After	Improvement (%)
Knowledge gained	.982	3.140	3.95
Teamwork	.921	3.632	17.78
Love	.684	3.711	0.68
Happiness	.684	3.711	0.68
Respect	.447	3.526	1.98
Confidence	.579	2.947	9.20
Response to facilitator		3.842	-

Table 2 above shows the result of the analysis of the feedback form that was given to the participants before and after the program. It shows the differences in average points of seven criteria before and after the program. Based on the numbers, there are improvements in every aspect of evaluation.

The aspect with the most improvement is teamwork, with a 17.78% improvement from 2.921 to 3.632 out of 4. This proves that this program has dramatically improved the teamwork of the participants, provided that they were doing activities in the group throughout the program. STEM @ KERAKED delivers a platform for the participants to perform tasks in an interactive way in which their cooperation is one of the significant aspects that lead to success.

The aspect that has the second-highest improvement in confidence with a 9.2% improvement from 2.579 to 2.947 out of 4. Before the start of the program, we asked about their confidence level in creating something related to

STEM, which most of them were not confident enough. Throughout the program, we introduce the participants with many simple activities that they can try related to STEM, hence changing their perception regarding STEM. Other than STEM is fun; it is also possible and easy to be mastered.

Knowledge is the aspect with the third-highest percentage of improvement, with a 3.95% improvement from 2.982 to 3.140 out of 4. The main objective of the program has been achieved that is to increase the knowledge and interest of STEM among students. At the same time, they are encouraged to use their critical thinking skill in order the improved the model created that can make their group stand out from the others. The other enhanced criteria are respect, happiness, and love. The response to facilitator criteria has mark the highest rating above all that is 3.842 out of 4.

Some of the participants initially did not like science because of their wrong perception towards this subject, like “Science is not fun” and “Science is difficult.” STEM @KERAKED introduced them with an attractive way of learning based on group activity to let them having fun while learning something new. Thus, this program has succeeded in the effort to attract the participants towards science, technology, engineering, and mathematics field. This is one of the substeps to establish a scientific and progressive society that has been stressed in Vision 2020.

Informal science learning, experiential learning (theory).

5. THE BENEFIT TO THE FACILITATORS

Table 3 shows the facilitators of this program’s reflection on how their participation affected them as university students. Out of 5, they agree that it is essential to be involved in this kind of service-learning program, plus it has improved their communication skills.

Table 3. Reflection of the Facilitators

Aspects	Item Number	Average	Average (Aspect)
Communication Skill	1	4.27	
	2	3.53	
	3	4.13	
	4	4.07	4.00
	1	4.33	

Perception Of Service Learning	2	4.13	
	3	4.20	
	4	3.27	
	5	4.13	
	6	4.00	4.01

As organizing STEM @KERAKED needed activities proposed by the university students themselves, with the supervision of their lecturer, academic staff in the campus, they need to communicate a lot during the planning, presenting the ideas, discussion among team members and it included giving and receiving instructions, which became the highest average for the item studied in Communication Skill aspect. This aspect shows soft-skill challenged and improved.

Although they needed to go out of their lecture hall and studied beyond their current semester syllabus for STEM @KERAKED, Table 3 also shows that they agree that university students need to participate and organize community service during their study.

This finding match statements stated by...(a reference to service-learning & communication skills)

6. CONCLUSION

STEM @KERAKED has achieved its objectives that are exposing and increasing the knowledge of science, technology, engineering, and mathematics among primary school students that participates in this program while enhancing their interest in STEM to attract the new generation towards the career based on STEM. This is one of the efforts to reach the 60:40 ratio that was set by the government for the development of our country. This program is just a stepping stone where we introduce some activities related to STEM in a fun, interactive, and attractive way so that they can continue to develop their skills in this field with their friends even after the program. Besides, this program has successfully improved the teamwork among the participants, attracting them towards performing tasks in a group compared to doing it alone before the program. Moreover, the benefits and improvements are not only can be seen from the participants; this program also gives an excellent experience for the crews and facilitators while improving their leadership skills before they graduate and enter the industries.

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