

Interactive STEM Talk and Workshop Outreach Programme-By Students, for Students: A Malaysian Context

Yaw Long Chua, Pooi Ying Choong
College of Engineering
Universiti Tenaga Nasional
Selangor, Malaysia
chuayl@uniten.edu.my, choongpooiying@gmail.com

Abstract— Malaysia has not been able to achieve the 60:40 ratio of STEM stream to arts stream students as formulated by the Malaysian Planning Committee of Higher Education in the year 1967. An interactive STEM talk and workshop outreach programme was conducted by a team of university students and benefited many secondary school students throughout Malaysia. Surveys were done based on the programme and it was found that Malaysian students lack the opportunity to participate in such workshops. Based on the survey results, participants of the workshop had a positive learning experience during the Interactive STEM Talk and Workshop, and it managed to emphasize on the importance of STEM education.

Keywords—STEM outreach, interactive talk, interactive workshop.

I. INTRODUCTION

The need to attract and encourage appreciation towards Science, Technology, Engineering and Mathematics (STEM) education among Malaysian students must be increased as the number of STEM students are dwindling in Malaysia. According to the Education Minister of Malaysia, Dr. Maszlee Malik, students in the STEM stream only make up of 44% the total number of Malaysian secondary school students in the year 2018 as compared to 48% in the year 2012, signifying an approximate reduction of 6000 students on average per year in secondary school science stream [1] [2].

The 60:40 Ratio Policy was formulated by the Malaysian Planning Committee of Higher Education in the year 1967, proposing that the ratio of STEM students to Arts students at upper secondary schools and university level to have a ratio of 60:40 for science stream and arts stream students [3]. A publication in the May 2019 issue of the Jurutera monthly bulletin by The Institution of Engineers, Malaysia (IEM) demonstrated the enrolment of form 5 STEM students in the year 2016 is just at 48.6% and only 19.8% in pre- university STEM courses in the year 2017 based on the enrolment of 424,128 form 3 students in the year 2016 [4]. Regrettably, it is evident that the 60:40 Ratio Policy target has not been realized yet.

The worrying trend of declination of STEM students could affect the future of Malaysia as the lack of STEM students will affect the nation's talent pool. Being a developing nation, it is crucial that Malaysia produces sufficient STEM graduates to ensure the constant supply of STEM related professionals in the economy to sustain the workforce of Malaysia. On top of that, with Industrial Revolution 4 making waves around the globe, the emphasis on the field of STEM is greater than ever [5].

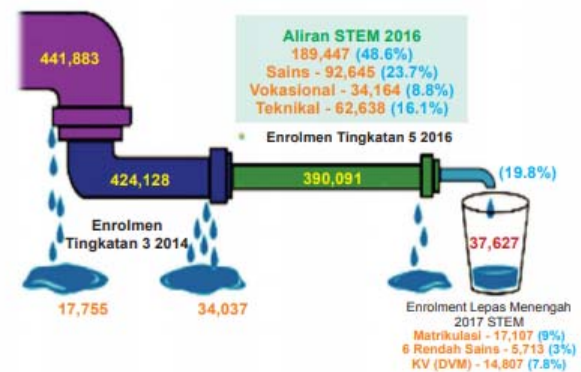


Fig. 1. The losses of students heading towards STEM is worrying. Adapted from May issue of IEM Jurutera Bulletin [4].

The aim of this outreach project is to develop an interactive STEM talk and workshop programme to increase interest and emphasize on the importance of STEM among secondary school students. Another aim of this project is to introduce to secondary school students that the process of learning STEM related subjects could be improved through play.

II. LITERATURE REVIEW

There are much efforts being done by various stakeholders to address the decline in STEM students in Malaysia such as the National STEM Movement, 'Minggu Sains Negara' national science week initiative [6], STEM education gamification through MySTEMville by the Ministry of Education Malaysia [7], Problem-Based Learning workshop [8], Engineering Outreach programs by professionals [9] and various STEM programs that utilize robots to increase interest in STEM [10] [11].

Efforts could be focused on attracting secondary school students to incline towards STEM education by having university students serving as volunteer facilitators in organizing interactive STEM talk and workshop for lower secondary school students in Malaysia. The interactive STEM talk and workshop place focus on informal learning through collaboration with STEM related agencies such as engineering learned societies and have contemporary youth-oriented delivery methods, which was suggested by Shahali, Ismail and Halim in the paper STEM Education in Malaysia: Policy, Trajectories and Initiatives [12].

III. IMPLEMENTATION OF INTERACTIVE STEM TALK AND WORKSHOP

This outreach programme involved various secondary schools across Peninsular Malaysia. A typical Interactive STEM Talk and Workshop is conducted in a hall of a secondary school in Malaysia and could accommodate up to 120 students per session. Each Interactive STEM Talk and Workshop duration is between two to three hours and is held during stipulated timeslot provided by secondary school involved. The program started off with the Interactive STEM Talk where students listen and interact with the speaker who exposed students to the importance of STEM education. The program then moved on to the workshop session where hands-on, learning through play activities took place. The STEM workshop is a platform for the facilitators to interact up close with students, encouraging fun learning of STEM subjects through play using professional STEM teaching aid from Fischertechnik (FT) Germany and DIY hands-on STEM activities. During the workshop session, the students are grouped into 10 students per group to ensure that everyone participating in the workshop have the opportunity to engage in hands on learning and better understand theories learnt in classroom. The groups take turns to participate in learning activities using FT teaching aids and DIY hands-on STEM activities with the guidance of program facilitators that are known as STEM Ambassadors. Standard activity sheets designed by the project organizing committee are used by the STEM Ambassadors to explain the activity being done and all materials will be provided to the students. Depending on the workshop duration, the DIY hands-on activities for each workshop varies, suiting the timeframe provided but still maintain the objectivity of the project.

Survey was conducted at the end of a session to measure the effectiveness of having interactive STEM talk and workshop to emphasize on the importance of STEM education among lower secondary school students and to obtain feedback on the utilization of teaching aid in STEM subjects for lower secondary school.

A. Interactive STEM Talk

An interactive STEM talk titled STEM Education: Malaysia's Future in the 21st Century is designed to be educate the target audience on the importance of STEM education. The presentation slides for the talk is designed to attract the attention of students with a lively, science themed background.

By utilizing word processing software Microsoft Office Power Point, a highly attractive presentation slide with interesting graphics, visual aids and animations that suit the age of the target audience and able to emphasize on the importance of STEM education was developed. The presentation of talk is done in a free and easy manner that made it easy to understand and is delivered in a fun, interesting and meaningful manner instead of a formal presentation. This ensures that the talk is a two-way interactive and fun learning session that could stimulate curiosity and learning for the audiences. Audiences are encouraged to ask as many questions possible related to STEM so they can have their minds open up towards the topic.



Fig. 2. Student volunteer interacting with the participants during the STEM talk.

B. Workshop Curriculum Design

Several FT professional STEM teaching aids were obtained for this project as the project organizing committee believes that the teaching aids were able to enhance student's learning experience by triggering psychomotor and cognitive abilities. This ensures learning is more effective as students are able to feel and touch the teaching aid on top of relating to theories learnt in classrooms. Each FT teaching aid is complimented with an explanation sheet which explains the basic working principles of the FT set designed by the project organizing committee. The FT professional STEM teaching aid available for this project are as follows:

- Mechanic + Static 2
- Pneumatic 3
- Pneumatic Power
- Solar Power
- Optics
- Tractor Set IR



Fig. 3. Student volunteer explaining the FT professional STEM teaching aid to curious participants.

On top of the FT professional STEM teaching aids, DIY hands-on STEM activities are part of the workshop curriculum. DIY hands-on STEM activities utilizing low value materials such as popsicle sticks, tape, syringes, plasticine and recycled materials are done to demonstrate and expose students that learning STEM could be fun and interesting without the need for expensive equipment, but instead could be done using commonly available household items. Activity sheets that contain theories and working

principles along with real life applications were planned and produced by the project organizing committee. All activities were designed to serve as a platform for students to practice and apply science theories such as pressure, force, density, buoyancy and etc. learnt in the lower secondary science syllabus, thus igniting their interest in STEM education.

Various DIY hands- on activities that are included in the workshop curriculum are as follows:

- Simple pneumatic lifter
- Recycled Plastic Bottle Diver (Cartesian Diver)
- Flying Contraption
- Self- Supporting bridge
- Catapult Challenge

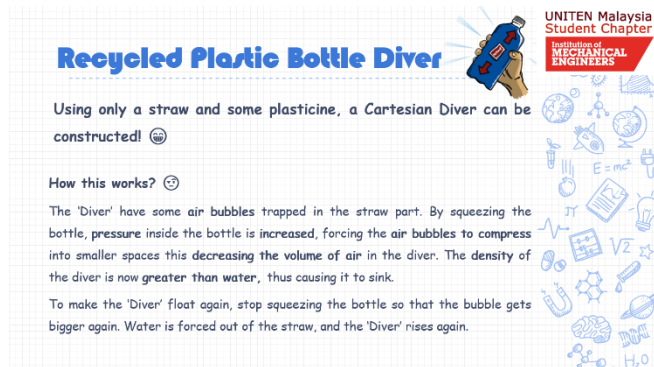


Fig. 4. Sample activity sheet of Recycled Plastic Bottle Diver for DIY hands-on activity.

The workshop curriculum is designed in such a way that it inculcates positive learning experience in STEM. By making STEM activities interactive, hands- on, and fun, students are able to experience firsthand learning through play, practicing theories learnt in classroom in real life, thus understanding the importance of STEM in real life applications.



Fig. 5. Participants attempting the self- supporting bridge activity.

IV. SURVEY METHODOLOGY

To measure the effectiveness of the Interactive STEM Talk and Workshop, surveys were carried out involving programme participants upon the completion of the program. A questionnaire form designed to obtain response regarding participants' interest and understanding in STEM, level of STEM exposure among students, workshop feedback, and teaching aid feedback from participants containing 12 questions provided were given to participants.

TABLE I. QUESTION NUMBER AND RESPECTIVE QUESTIONS IN SURVEY.

Question No.	Question
Q1	Age
Q2	Gender
Q3	Do you understand the meaning of STEM?
Q4	Have you participated in a STEM workshop prior to attending this programme?
Q5	Do you find this programme useful for you in the future?
Q6	Will you recommend this programme to your family and friends?
Q7	Interactive STEM talk provided important information related to STEM.
Q8	The STEM activities helped in understanding science theories better.
Q9	Teaching aid used during the workshop sparked interest in STEM education.
Q10	Want teachers to utilize teaching aids in teaching STEM subject classes.
Q11	Overall, the STEM outreach programme has given me positive learning experience in STEM.
Q12	STEM education is important for your future.

V. SURVEY RESULTS AND DISCUSSION

This section of the paper will present and discuss the survey results obtained. There are total of 117 survey participants for this project. As summarized in Fig. 6 below, the demographic data of participants for the workshop are distributed among 14 years old till 16 years old students, with 15 years old students which are in lower form 3 having the highest frequency. The amount of male and female participants that responded to the survey is well distributed with 47.9% male respondents and 52.1% female respondents.

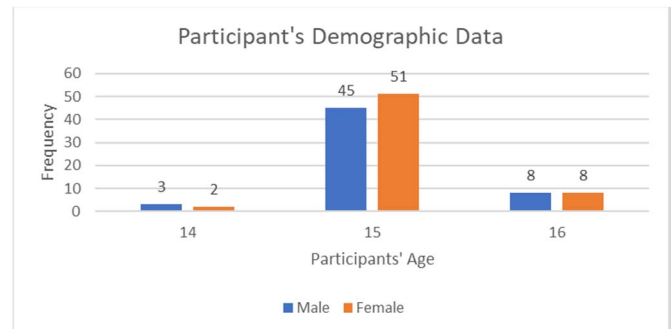


Fig. 6. Survey Demographics.

The exposure level of STEM among participants is shown in Fig. 7, it was found only 89.7% of the respondents understood the meaning of STEM. This is worrying as it shows that there are still secondary school students in Malaysia that are unaware of what STEM education is despite the fact that under the national education system, students are systematically exposed to STEM related subjects at an early age starting from primary school year 1 [13]. On top of that, there are only 21.4% of respondents who had participated in a STEM workshop prior to attending this programme. This data demonstrated that there might be a lack of easily accessible STEM programmes to ignite the interest and emphasize the interest in the field of STEM among Malaysian children.

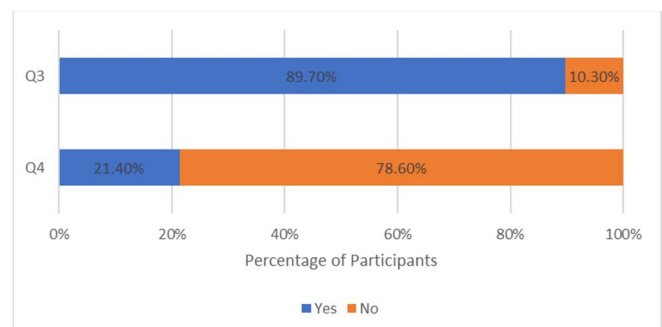


Fig. 7. Exposure level of STEM among participants.

From the survey results as shown in Fig. 8, it was found that 91.5% of the programme participants find that this programme is useful for them in the future. Notably, 85.5% of respondents stated that they will recommend the interactive STEM talk and workshop to their family and friends. This provided an understanding that the STEM programme done is successful, with the participants satisfied with the contents and delivery method of the programme, and participants feel that they benefited from the programme.

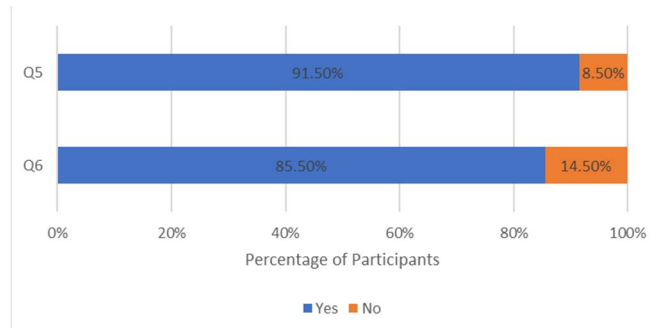


Fig. 8. Programme feedback from participants.

It is evident from the results shown that majority of the respondents agreed that the interactive STEM talk provided important information related to STEM and the interactive STEM activities done during the workshop could aid in understanding science theories as summarized in Fig. 9. These data signified that by having STEM programmes with interactive, hands on activities, a student can understand and relate these theories to real- life application better which in end could ignite the participants' interest in STEM, making them more confident and comfortable in learning STEM related subjects.

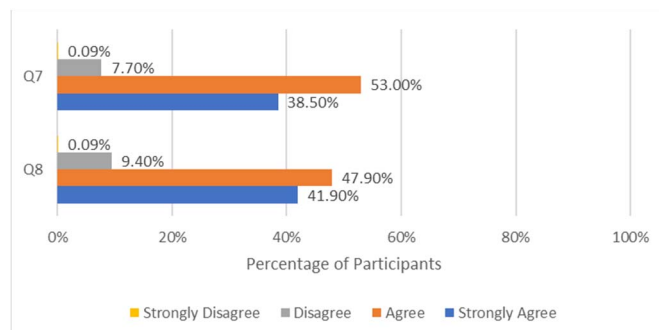


Fig. 9. Feedback of STEM talk and activities

Moving on to the FT teaching aids utilized during the workshop session. Fig. 10 summarized the feedback on teaching aids by participants. It was observed that majority of the participants agree that the teaching aid used during the workshop sparked interest in STEM education and want their teachers to utilize teaching aids for STEM subject classes. This reflects that students' approach towards learning will improve as with various teaching aids available, learning STEM subjects will be a positive experience as it is easier for students to visualize the theories taught by teachers. Apart from that, teaching aids allow students to bridge theory with practice as they are able to witness real world applications of scientific theories learnt in classes using specially designed FT professional STEM teaching aid that demonstrates various scientific theories as according to which set is used. Indeed, the data obtained supports the usage of teaching aids in delivering STEM subjects.

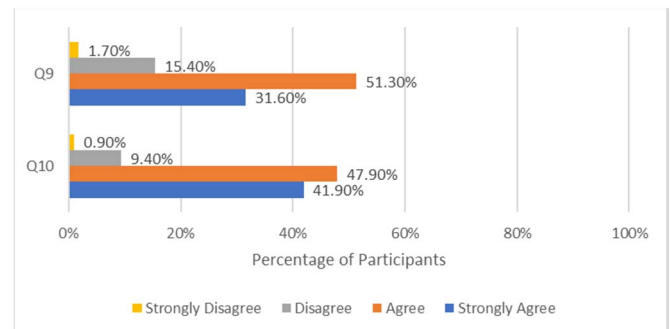


Fig. 10. Feedback on teaching aid.

Fig. 11 shows the overall feedback of the Interactive STEM talk and Workshop. Majority of participants had a positive learning experience during the Interactive STEM Talk and Workshop. This signifies that the interactive STEM talk and workshop programme organized is impactful and beneficial towards the participants, at the same time able to emphasize on the importance of STEM among lower secondary school students.

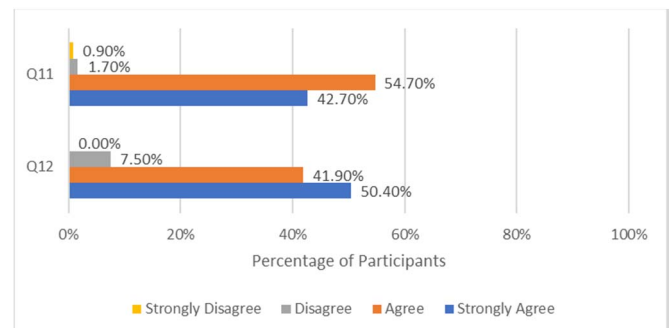


Fig. 11. Overall feedback of the Interactive STEM Talk and Workshop.

VI. CONCLUSION

The interactive STEM talk and workshop has achieved its objective in increasing interest and emphasize the importance of STEM among lower secondary students. The involvement of students in this program has brought a youth oriented, informal learning session that enabled participants understand the importance and learn STEM concepts in a fun manner with facilitators. Students as volunteer facilitators also act as a source of motivation and inspiration to the students as they shared their interesting learning experience in university, and they are more willing to ask questions as they felt more comfortable speaking to facilitators with smaller age gap. A limited study was conducted on a group of secondary school students in Peninsular Malaysia to obtain feedback for the interactive STEM talk and workshop. Survey results shows very promising findings as most respondents provided positive replies to the survey as discussed in the results and discussion section.

It is suggested that further studies could be done on larger groups of respondents and the interactive STEM talk and workshop could be brought to more schools around Malaysia to include respondents from both urban and rural areas with different socio- economic status and different cultural background to obtain data from a more diverse range of respondents. In addition to that, the contents of the interactive STEM talk and workshop should be updated frequently and new activities and materials should be added to follow the current trends so participants will be interested with the

contents and it will stay relevant with current real- life applications to scientific theories. Further development of the activity sheets for workshop session should be done to improve on the contents and also design to make it more interesting and interactive for participants. Based on the survey results obtained, the interactive STEM talk and workshop is able to increase interest and emphasize the importance of STEM among lower secondary students, thus more efforts of such programmes are needed attract and encourage appreciation towards science, technology, engineering and mathematics (STEM) education among Malaysian students.

ACKNOWLEDGMENT

The authors will like to offer sincere gratitude to the Institution of Mechanical Engineers (IMechE) for awarding IMechE UNITEN Student Chapter the Schools & Clubs Engineering Challenge Fund Awards to undergo this project. The authors would also like to thank the student volunteers who served as STEM Ambassadors throughout this project. Last but not least, the authors would like to thank the administration and students of all secondary schools that supported and participated in this project.

REFERENCES

- [1] C. Chin, "Interest in science continues to drop," 17 March 2019. [Online]. Available: <https://www.thestar.com.my/news/education/2019/03/17/interest-in-science-continues-to-drop/>.
- [2] "Less students taking STEM each year: Maszlee," 12 Marth 2019. [Online]. Available: <https://www.thesundaily.my/local/less-students-taking-stem-each-year-maszlee-AC675323>.
- [3] F. A. Phang, M. S. Abu, M. B. Ali and S. Salleh, "Faktor Penyumbang Kepada Kemerosotan Penyertaan Pelajar dalam Aliran Sains: Satu Analisis Sorotan Tesis," *Sains Humanika*, pp. 63-71, 2014.
- [4] IEM, *Developing Engineering Workforce, Designing a Better Future.*, May 2019 ed., The Institution of Engineers, Malaysia., 2019, pp. 23-29.
- [5] "STEM literacy for industry 4.0," 21 October 2018. [Online]. Available: <https://www.thestar.com.my/news/education/2018/10/21/stem-literacy-for-industry-40/>.
- [6] "Minggu Sains Negara," 2019. [Online]. Available: <https://www.mestecc.gov.my/web/minggu-sains-negara/>.
- [7] MOE, "MALAYSIA EDUCATION BLUEPRINT 2013-2025 Annual Report 2017," Ministry of Education Malaysia, 2017.
- [8] Z. Ismail, F. M. Mohamad, H. Harun, N. A. Muda and Y. M. Yusof, "Integrated Science, Technology, Engineering, Mathematics Learning in Natural Disaster Earthquake among Form Two Students," in *2017 7th World Engineering Education Forum (WEEF)*, Kuala Lumpur, 2017.
- [9] B. Balakrishnan and M. N. A. Azman, "Professionals Back to School- An Engineering Outreach Programme: A Case Study in Malaysia," *Journal of Engineering Science and Technology*, pp. 2640-2650, 2017.
- [10] M. Ali, J. Surif, N. M. Zaid, C. A. Talib, A. H. Abdullah and N. H. Ibrahim, "The Effectiveness of a Mentor- Mentee Program on Malaysia School Students' interest in STEM," in *2018 IEEE International Conference on Teaching, Assessment, and Learning for Engineering (TALE)*, Wollongong, 2018.
- [11] T. T. Tay, Z. Z. Lim and Y. L. Chua, "Utilizing Autonomous Mobile Robot to Increase Interest in STEM," in *2017 3rd International Conference on Science in Information Technology (ICSITech)*, Bandung, 2017.
- [12] E. H. M. Shahali, I. Ismail and L. Halim, "STEM Education in Malaysia: Policy, Trajectories and Initiatives," *Asian Research Policy Science and Technology Trends*, pp. 122-133, 2017.
- [13] C. H. Ng and M. Adnan, "Integrating STEM education through Project-Based Inquiry Learning (PIL) in topic space among year one pupils," in *IOP Conference Series: Materials Science and Engineering*, 2018.