The perception of pre-university students on STEM

N M Nawawi¹, ², *, N M Sout², K B Hassan², N N A Samah¹,², H H Kamaruddin², R M Khalid² and H H Azman²
¹ Selangor BioIT Institute, Universiti Selangor, MALAYSIA
² Centre for Foundation and General Studies, Universiti Selangor, MALAYSIA

* E-mail: norazah@unisel.edu.my

Abstract. STEM is an integrated teaching and learning approach in Science, Technology, Engineering and Mathematic. The decreasing enrolment of students in STEM-field is alarming and impacting the industry as well as the university students’ intake. This study is focusing on one hundred of pre-university (foundation) students by looking at their understanding on STEM education and the impacts of STEM module in nurturing their interest on STEM. The study applied naturalistic inquiry to assess their perceptions of STEM prior and subsequently after involve in a STEM module activities. The results showed that majority of students are female and from different background, they are interested in learning science shown by the increase of agreement to 38% and 40% after the activity with the decrease in the percentage of neutral and disagree level. The percentage of interest on STEM was decreased after the activity. However, the level of confident about their ability towards science was increased. The confident level lead the respondents to choose career related to science/STEM based on the increase level of agreement from 22% to 28% and from 24% to 32% for strongly agree and agree relatively. Hence, the outreach with attractive activities would potentially add value for students’ intrinsic motivation for science and science learning.

Keywords: pre-university, foundation, STEM perceptions, STEM module

1. Introduction

STEM education is facing a great challenge in this digital revolution in which science and technology play a central role in our lives. "STEM" is an acronym for the discipline of Science, Technology, Engineering and Mathematics. STEM education has been differently described in terms of regional needs [1]. Moore et al. [2] defines that integrated STEM education is “an effort to combine some or all of the four disciplines of science, technology, engineering, and mathematics into one class, unit or lesson that is based on connections between the subjects and real-world problems”. Integrated STEM education quoted by [1] as “the approach to teaching the STEM content of two or more STEM domains, bound by STEM practices within an authentic context for the purpose of connecting these subjects to enhance student learning”. As a means of becoming a developed country, Malaysia places great emphasis on STEM education and achieving the targeted number of STEM employees and eventually meeting the challenges and demands of a STEM-driven economy by 2020. The government of Malaysia via The Latest Economic Model (NEM) aims to build 1.3 million STEM jobs in different sectors by 2020, enabling infrastructure and encouraging the growth of STEM by 2020 in support industry clusters.

In most countries, however, there has been a decrease in the number of students studying Science, Technology, Engineering and Mathematics (STEM) associated areas at the level of secondary and...
tertiary education. [3]. Despite the focus on STEM, for a majority of Malaysian high school students whose interest in science subjects has been steadily declining, science and mathematics are not subjects of first preference. Recent studies have shown that school science engagement and motivation among secondary school students to choose science-related careers is alarming, as students reject science-related careers as a future career option [4], [5]. Many students in secondary school and post-secondary were switching from STEM majors to other fields [5]. Moreover, it was found only half of those students who originally studied STEM majors actually completed STEM degrees. Although STEM-related labour demand has increased, interest in science-related subjects continues to decline.

A target of the STEM to Arts stream student ratio of 60: 40 percent was proposed by the Higher Education Planning Committee's as a roadmap to becoming a developed nation by 2020. The truth on the ground clearly illustrates a reverse pattern where the stream of arts tends to dominate well above the combined stream of science, technical, vocational education and training (TVET). According to [6], the number of students pursuing education in the science stream decreased from 48.15% in 2012 to 45.74% in 2017. These statistics are alarming since it is far away from the Higher Education Planning Committee’s set target to achieve their 60:40 Science: Art Policy [7] although four out of five new jobs reported in Malaysia is related to STEM fields. Statistics from the Malaysia Ministry of Education showed that the number of students enrolled in fields related to Science, Mathematics, Computer, Engineering, Manufacturing, and Construction, at public and private higher learning institutions, was 334,742 which are much lower than the 570,858 enrolled in Arts and Humanities, Education, Social Science, Business, and Law.

Aware of this problem, The National STEM Movement and many institutions has taken the step forward to make the Malaysia Education Blueprint a reality by initiating STEM Outreach Program in schools facilitated by universities as well as STEM program among foundation student. The objectives of study is focusing on the pre university (foundation) students by looking at their understanding on STEM education and the impacts of STEM module in nurturing their interest on STEM. It also to raising student interest through new learning approaches, sharpening skills and abilities of lecturers and building public and student awareness.

2. Methodology
The study was conducted among 100 pre-university (foundation) students with different background. We used a naturalistic inquiry to examine foundation students’ perceptions of STEM prior and after participating in a STEM module activity as an informal learning experience. The changing of perception towards STEM were evaluated at the end of the program using short survey answered by participants. A survey in Likert-scale format and open questions was given to the students. Table 1 show the questions asked to the students.

Table 1: A survey question to the participants.

| Number | Question |
|--------|----------|
| 1      | I am interest in STEM. |
| 2      | Interest in Career STEM. |
| 3      | Interest in learning science. |
| 4      | I am good at Science |
| 5      | I understand the meaning of STEM. |
| 6      | I am aware of the importance of the STEM field. |
| 7      | I am interested in learning and know more about STEM. |
| 8      | I feel other areas besides STEM are better. |
| 9      | I feel the STEM field is an easy field. |
| 10     | I will probably withdraw from the STEM majoring course before I graduate. |

Responses from respondents about the perception towards STEM in this study was measured using a Likert scale. This research data is in the form of quantitative data and analysed using descriptive statistics. The results of the questionnaire data are processed using Microsoft Excel and SPSS software.
[8]. Question number one to eight focus more on Science, Technology, Engineering and Mathematics meanwhile question 9 and 10 focus direct to science subject. There is one open-ended question, for those who want to change or withdraw from STEM or Science courses to other fields.

3. Result and Discussion

The perception on STEM among foundation students was evaluated in this study. In order to know the view of students, this study examines the understanding of foundation students about STEM which related to their exposure and learning stage during secondary school. The impacts of STEM module in nurturing their interest on STEM were tested. The students who participated in the module activities were measured on their STEM knowledge and dispositions before and after participated in an activity that introduces hands on module. In the literature, outreach refers to activities whose main objective is to promote awareness of STEM in real life and to make a contribution to STEM education to motivate learners. This study was conducted to know the perception of pre-university students enrolled in University Selangor towards STEM as the reduction of STEM student is alarming.

3.1 Personal Background and Perception on STEM

Out of 100 respondents, 66% were female and 44% were male. From the questionnaire, gender significantly not related to students perception towards the important of STEM. By using independent t-test, found that p-value for each element is greater than 0.05 means there is strongly no significant related between gender and each perception criterion as shown in Table 1. The highest p-value is 0.932 shows that participants are really interest towards Science, Technology, Engineering and Mathematics.

Table 1. Relation of Perception between Gender.

| Perception Criterion                                      | p-value |
|---------------------------------------------------------|---------|
| I am interested in learning science                      | 0.654   |
| I am interested in STEM                                 | 0.932   |
| I am good at Science                                    | 0.631   |
| I am interested in a career in Science/STEM              | 0.591   |

From the Frequency Table and bar chart for each perception criterion, 34.9% from the respondent agreed that they are good in Science subject. Majority 51% of these respondents joined the activity because they wanted to learn. Meanwhile, some of the participants attended this activity as they were influenced by teachers and friends. Another reason that contributes to the percentage of participants joining the activity is because the activity is new for them and they think it is fun.

Based on demographic data, most of the respondents grown in town 66%, 23% in capital city and the rest of 11% were from rural area as depicted in Figure 1(a). Overall, 34% joined STEM Seminar because of they want to learn, followed by 17% were influenced by lecturer, 16% feel that STEM is
something new to explore, meanwhile 12% said it fun and the least is 4% was influenced by their friend as shown in Figure 1(b). Table 2 shows the percentage of respondents’ perceptions towards STEM. From choices of answer for the pre question survey why do you think STEM is important?, only 32% and 38% respondents were strongly agree and agree that they were interested in learning science. After the activity, the post survey shows the increment of 38% and 40% for the answers strongly agree and agree respectively. In contrary, the percentage of neutral and strongly disagree answer were decreases. From another aspect, the level of confidence about their ability towards science was increased. It might be occur as the respondents observed their ability to handle the activities and relate with daily life applications. The confident level lead the respondents to choose career related to science/STEM based on the increase level of agreement from 22% to 28% and from 24% to 32% for strongly agree and agree respectively.

| Perception Answer | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
|-------------------|----------------|-------|---------|----------|------------------|
| Pre test          | Post test      | Pre test | Post test | Pre test | Post test | Pre test | Post test |
| I am interested in learning science | 32 38 | 38 40 | 20 15 | 4 5 | 16 2 |
| I am interested in STEM | 29 23 | 41 29 | 21 34 | 4 3 | 7 11 |
| I am good at science | 11 16 | 30 36 | 34 32 | 14 8 | 1 8 |
| I am interested in a career in science/STEM | 22 28 | 24 32 | 36 23 | 8 7 | 10 10 |

The findings indicate that pre university students who participated not only reported gains in their STEM content knowledge, but also showed an improvement in their interest and their perceptions about STEM subjects and careers. The results of the study suggest that carefully designed STEM module activities that encourage inquiry-based learning can be very effective at the pre university students. Long-term problem-based activities and the perspective of new views of science and scientists were perceived as providing the most positive learning environments. Additionally, outreach learning environments can create opportunities to increase students’ motivation in STEM.

3.2 Knowledge on STEM

Foundation study is an important stage in student development as a university students and a preparation for a changing future. Judith Ramely introduced the acronym STEM that explained that math and science are used as the book-ends for engineering and technology [8]. The science, technology, engineering and mathematics (STEM) skills that students understand during secondary school and the foundation is a key for a successful career in STEM. Moreover, most STEM occupations require competencies in science, math and logical thinking prior to engagement in problem solving. Therefore, it is vital to prepare and develop interest in secondary school students and foundation level to participate in the future STEM workforce. STEM field require new knowledge and skills, such as flexibility, multidisciplinary problem-solving, teamwork and communication [9]. We test the knowledge of respondents. From choices of answer for the statement I understand the meaning of STEM, almost 70% agree that they understand the meaning of STEM and 75.6% ‘aware of the importance of the STEM field’. The survey also test whether the respondents interested to ‘learn and know more about STEM and 65.4 % agree that they are interested in learning and know more about STEM. The survey anticipate the hope that this group will increase their interest in the field of STEM.
From previous report, the lack of students’ interest in STEM-related subjects leading to poor achievement is due to many factors, such as parental encouragement, as well as the anxiety of teachers and students themselves. According to [10], one of the reasons of declining number of students’ enrolment for STEM subjects is due to students feel that the subjects of the STEM discipline are complicated, unexciting and boring. This study agreed with [11] mentioned that lack of students’ interest, which then bringing them to be involved in non-STEM subjects due to lack of interest and minimal knowledge of STEM subjects among secondary students. However, from our survey, only 23.1% agree with the statement ‘I feel other areas besides STEM are better’ and 32% of the students feel the STEM field/area is an easy field/area.

Careers contribute to this factor which is the lack of awareness of the wide range of careers that students can enter with a science background. It is due to the lack of access to the real STEM profession opportunities students are unable to see these disciplines as springboards for their careers [12]. In addition to the lack of interest from students in STEM subjects, Malaysia also faces problems with adequate integrated STEM exposure and training. STEM-related information and knowledge is quickly updated and outdated that some teachers are left behind in this new advancement and knowledge in Science and Mathematics [13]. Apart from that, teachers’ attitudes and content knowledge are among the main factors that contribute to students’ lack of interest [14], so, qualified and most passionate teachers can also help increase students’ interest in STEM related subjects [8]. If they have adequate information, definitely this generation with choose STEM field as shown from the an open ended question in the survey, where most of the students with 53.9% would not withdraw from the STEM course means they will pursue their next level of study in STEM field or Science area.

Based on the results obtained, more work needs to be done in order to understand how best to support public especially pre-university student as they attempt to integrate STEM education into their study [15]. Research into effective formative assessment strategies during STEM education needs to be conducted. Effective ways to gauge student understanding would yield more efficient STEM talent development. An outcome from this study about the relationship between background students during high school with their interest in learning and know more about STEM shows a positive relationship between the two factors, but with the R-value is 0.085, it shows a very weak relationship. Therefore, students from various background can success in STEM field if they have a proper guidance and opportunity. STEM education in several countries is changing as well. Education is being changed by putting an emphasis on the promotion of positive attitudes towards STEM and by efforts to increase the number of students choosing STEM courses and careers in many countries [16], [17].

In order to maintain this perception, it is not only necessary to keep students motivated, but also to increase motivation for STEM among groups of students who usually do not choose STEM. In the current study, we proposed outreach activity as a possible means to achieve the goal. What many contemporary STEM courses share is an attempt to intertwine contexts from real life with those in schools. Colleges and universities have developed several activities to bridge the gap between high schools and higher education during the last decades. These activities help students to experience authentic science investigations with hands-on activities. This serves to increase student motivation for choosing STEM by connecting textbook theory with ‘real’ life science. More awareness of STEM in real life will increase motivation for STEM and choosing STEM in the future [18].

4. Conclusion
In this study, STEM module activities was used as a tool that give an informal learning experience for pre-university students and their perception and interest on STEM before and after the activities were taken into account and were analysed. This study is very important to be conducted because the students’ perception has a big significant on their choice of field of study and subsequently their choice of career in the future. Although the students are from science stream in the secondary school, but not necessarily their preference to further in STEM field at tertiary level based on about career in STEM which not achieve 30% of respondents’ interest. Some of them may prefer to choose other fields such as Arts and Humanities, Education, Social Science, Business, and Law.
However, these findings show a positive student perceptions of the informal learning education because the hands on activities that we offered are more to the applications of STEM in daily life that enable students use STEM knowledge they had learned in secondary school in order to solve the real-life problems. Indirectly, these activities have created awareness of the importance of STEM in future job as the Industrial Revolution 4.0 was grown rapidly not only in this country but also in the world. Other than that, these STEM activities would potentially add value for students’ intrinsic motivation for science and science learning. Like it or not, students should prepare themselves with STEM knowledge and relevant skills to suit with criterion needed to get these future job. Student who did not ready to coop with this fast changing revolution will left behind and always become the last choice to get the job.

As a conclusion, the responsible to increase the student interest in STEM field should be taken by all party includes students, teachers, parents, school, higher institution, government, non-government organizational and also public as a whole. The outreach activities would potentially add value for students’ intrinsic motivation for science and science learning. A good embedding of outreach into regular curriculum by government is needed, because students benefit by seeing new contexts and possibilities within the STEM-based world that might influence their perception and attitudes towards STEM. This embedding will give them the opportunity to connect school science with the outside world by themselves. All parties must cooperate to support the plan and strategies.

Acknowledgements
The authors gratefully acknowledge Prof (E) Dato’ Dr. Abdul Latif Ibrahim the founder of STEM squad in UNISEL as well as the opportunity and support from Universiti Selangor, National Stem Movement and Centre for Foundation and General Studies for respondents.

References
[1] Kelley T R and Knowles J G 2016 A conceptual framework for integrated STEM education. International Journal of STEM Education, 3(1), 11.
[2] Moore T J, Stohlmann M S, Wang H H, Tank K M, Glancy A W and Roehrig G H 2014 Implementation and integration of engineering in K-12 STEM education In Engineering in pre-college settings: Synthesizing Research, Policy, and Practices (Purdue University Press)
[3] Alan B, Zengin F K and Kececi G 2019 Using STEM applications for supporting integrated teaching knowledge of pre-service science teachers. Journal of Baltic Science Education, 18 2 158-170
[4] Siew N M, Amir N and Chong C L 2015 The perceptions of pre-service and in-service teachers regarding a project-based STEM approach to teaching science Springer Plus 4 8 1-20
[5] Shao-Na Zhou, Hui Zeng, Shao-Rui Xu, Lu-Chang Chen and Hua Xiao 2019 Exploring changes in primary students’ attitudes towards science, technology, engineering and mathematics (STEM) across genders and grade levels Journal of Baltic Science Education 18 3 466-480
[6] Academy of Sciences 2017 Science outlook report (Kuala Lumpur, Malaysia: Academy of Sciences Malaysia)
[7] Ministry of Education 2013 Malaysia Education Blueprint 2013 – 2025 (Kementerian Pendidikan Malaysia (MOE))
[8] Astalini A., Kurniawan D A, Kurniawan, N and Anggraini L 2019 Evaluation of Student's attitude toward Science in Indonesia Open Journal for Educational Research 3 1 1-1
[9] Voogt J and Roblin, N P 2010 Discussion paper: 21st century skills. http://www.kennisnet.nl/uploads/tx_kncontentelements/21st-Century-Skills.pdf. Accessed June 22, 2019
[10] Christenson J 2011 Ramaley coined STEM term now used nationwide Winona Daily News. Retrieved from http://www.winonadailynews.com/news/local/ article_457afe3e-0db3-11e1-abe0-001cc4c03286.html
[11] Subotnik R F, Tai R H, Rickoff R and Almarode J 2010 Specialized public high schools of science, mathematics, and technology and STEM pipeline: What do we know now and what will we know in 5 years Roeder Review 32 1 7-16

[12] Ergün A 2019 Identification of the interest of Turkish middle-school students in STEM careers: Gender and grade level differences Journal of Baltic Science Education 18 1 90-104

[13] Shahali E H M, Ismail I and Hashim L 2017 STEM Education in Malaysia: Policy, Trajectories and Initiatives Science and Technology Trends 122-133

[14] Jackson J K and Ash G 2012 Science Achievement for All: Improving Science Performance and Closing Achievement Gaps Journal of Science Teacher Education 23 7 723-744

[15] Dare E A, Ellis J A, and Roehrig G H 2014 Driven by beliefs: understanding challenges physical science teachers face when integrating engineering and physics. Journal of Pre-College Engineering Education Research 4 2 47-61 https://doi.org/10.7771/2157-9288.1098

[16] Bettinger E 2010 To be or not to be: Major choices in budding scientists In C. T. Clotfelter (Ed.), American universities in a global market (pp. 69–98) (Chicago: University of Chicago Press)

[17] Krapp A and Prenzel M 2011 Research on interest in science: Theories, methods, and findings International Journal of Science Education 33 27–50

[18] Van Griethuijsen R A L F, Van Eijck M W, Haste H, Den Brok P J, Skinner N C and Mansour N 2015 Global patterns in students’ views of science and interest in science. Research in Science Education, 45, 581–603.