STEM Facilitators Training Programme: Trainee Teachers' Perceptions of the Impact on their Personal Growth as Future Teachers

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Abstract: This study was conducted to find out the perceptions of Science and Mathematics trainee teachers on STEM Facilitator Training Program (SFTP) and to examine the impacts of SFTP on their personal growth as future teachers. The study employed a mixed-method design in which the data of the study were gathered through a short survey and group interview. The number of samples used for each method was dissimilar. 125 samples were selected by using stratified random sampling to answer the survey. The reliability of instruments used was determined by Cronbach's alpha coefficient = 0.944 > 0.6. indicating that the items used are highly reliable. Additionally, the researchers selected 6 pre-service teachers (3 respondents represented Science and Mathematics programmes respectively) to be involved in a semi-structured group interview. The study noted that they had high positive perception towards the programme. The design training programmes were suitable for the pre-service teachers as there is no significant difference in the respondents' perceptions. Irrespective of the semesters, the results specify that there is no difference in terms of their perception after participating in the programme. The pre-service teachers joined the program as most of them saw SFTP as a good platform to expand their ability as future teachers and to have a real experience dealing with school students. The study also reported that there were several skills and knowledge that the respondents gained throughout their involvement in SFTP. It is clear that SFTP has impacted the personal growth of the respondents as future teachers as they claimed to be more confident in delivering Science and Mathematics content, were able to speak with more control and order, found that their instruction had improved and knew the important aspects needed to give an effective delivery in class. Overall, they believed SFTP had helped them improve their skills as future Science and Mathematics teachers.

Keywords: STEM Teachers, STEM Education, Teacher Training, Pre – service Teachers

1. Introduction

Rasid, Nasir, Singh, & Cheong (2020) stated that the future of the economy is in STEM. The integration of disciplines like Science, Engineering, Technology, and Mathematics or commonly known as STEM education, is an emergent focus and interest in many countries. There is a general understanding of what STEM education is among scholars but there are also numerous versions of what it actually entails. This has caused integrated approaches to STEM remain a challenge for STEM educators around the globe (Breiner, Harkness, Johnson, & Koehler, 2012; Brown, Brown, Reardon, & Merrill, 2011). In addition, the declining number of students enrolling in STEM programmes is at a worrying state (Blackwell & Talia, 2017; Azian, 2015). As there are many countries moving towards better development, more skilled workers with a strong STEM background are needed. The shortage of skilled workers in the STEM areas will impose a significant threat to the development of a nation. Thus, STEM

education at all levels needs to be improved. In the current education setting, teaching the 21st century learners requires STEM teachers to be more versatile and flexible in order to provide learning which is more active and student centered (Rusdin, 2018; MOE, 2013).

The Malaysian Education Blueprint (MEB) has explicitly outlined that our education system must have teachers who are able to teach well in schools so that students' academic achievement can be improved (MOE, 2013). Moreover the complexities of today's world require students as future workers, to be equipped with problem solving skills, technological literacy, and logical thinking. These skills are the core in learning STEM whereby real life applications of the knowledge should be emphasised rather than theory-laden knowledge (Salehudin, Hassan & Hamid, 2015). The responsibility to teach more effectively and dynamically lies mainly on the teachers (Yahya, Ismail, Salleh, & Abdullah, 2015). However, it is not only applicable to the in-service but equally imperative to the pre-service teachers who are in teacher training institutions in Malaysia.

To date, there have been various initiatives undertaken by the government to intensify STEM activities among students, teachers, schools and communities (MOE, 2013) to ensure sustainability in the near future. In line with the emphasis of STEM education highlighted in MEB, Burrows and Slater (2015) highlighted that the implementation of integrated STEM can help the next generation of students to solve real world problems by applying concepts that cut across disciplines as well as enhance their critical thinking, collaborative and creative capacities. As mentioned previously, a teacher plays a vital role as he or she ensures fun, teachable moments that could sustain students' interest and motivation during STEM lessons. They also need to provide a sound yet scientifically correct explanation when asked by the students.

Past studies in various countries asserted that the integration of STEM in the classroom is a struggle for many teachers, especially in a heterogeneous classroom with students of different abilities and interests. Honey, Pearson and Schweingruber (2014) stated that most teachers receive training in only one discipline, and that most schools still have separate departments and class periods for STEM subjects, making it difficult for teachers to integrate STEM content. With regards to this issue, Breiner et al. (2012) argue that many educators approach STEM education with uncertainty because no single definition of STEM education exists, and many "do not have an interdisciplinary understanding of STEM". In other words, teachers neither share a unified understanding nor definition of STEM (Breiner et al., 2012). Brown et al. (2011) too echoed the issue of schools having different interpretations of STEM education. Eberle (2010) emphasized that a successful STEM education is one that provides students with practical Science, Mathematics, Engineering and Technology exposures in sequences that build upon each other. For effective integration of STEM to take place, several aspects like content knowledge, strong belief in innovative, student-centered teaching strategies; interdisciplinary learning processes that bridge across subjects, and strong teams that can create a culture of success in schools through professional communities must be seriously taken into consideration (El-Deghaidy & Mansour, 2015).

Looking at the common STEM education practices in Malaysia, subjects such as Science and Mathematics are still taught in isolation through a discipline-based approach with limited connections to real life situations. Also, there are numerous reasons that contribute to ineffective teaching and learning of integrated STEM, which include (1) teacher-centric pedagogical approaches employed in the classrooms which left students with minimal or no opportunities to be critical, creative and innovative (Salleh, Abdullah, Alias & Ismail, 2014); (2) lack of requisite content knowledge of Science and Mathematics among a substantial number of teachers (Edy Hafizan Mohd Shahali, Ihsan Ismail & Lilia Halim, 2017); (3) the practice of investing heavily on preparing students for examinations at the expense of exposure to practical elements of the curriculum (Ismail, Abdullah, Salleh & Ismail, 2017); and (4) limited and outdated infrastructure (Nur Farhana Ramli & Othman Talib, 2017). All the mentioned reasons contributed to genuine challenges in ensuring effective teaching and learning, in engaging students and in sustaining their interests toward STEM (MOE, 2013).

Similar to the above-mentioned situations, several studies also noted that Science and Mathematics teachers lack pedagogical knowledge and efficacy when it comes to STEM education (Nadelson, Callahan, Pyke, Hay, Dance, & Pfiester, 2013; Stohlmann, Moore, & Roehrig, 2012). Another study reported that STEM teachers expressed concerns that they are underprepared to use STEM applications in the classroom (El-Deghaidy & Mansour, 2015). Students' performance has deteriorated due to difficulties of the Science subjects and they could not relate what they have learned to real life situations

stemming from their teachers' incompetency (Rose Amnah Abd Rauf & Mohamad Sattar Rasul, 2017). Moreover, there is evidence for lack of 'learning by doing' approach in teaching, thus resulting in the lack of 21st century skills - computational thinking, problem solving, and critical thinking (Rose Amnah Abd Rauf & Mohammad Sattar Rasul, 2017).

The greater demands waiting for the current young generation of future teachers need to be taken into consideration before the pre-service teachers enter the school system. This situation has prompted teacher training institutions to prepare and equip pre-service teachers to become more versatile, flexible, capable of having a good set of skills in teaching. In line with the current circumstances, the Science and Mathematics Education Department, Faculty of Education of UiTM had established a STEM Facilitators Training Program (SFTP) to train the Science and Mathematics pre-service teachers to deliver the Science and Mathematics lesson in a more practical, fun, deep way of learning and in an integrated manner.

SFTP adapted the concept of mastery, exploration and excitement. The three concepts were applied to ensure that the future teachers were equipped to help students master concepts in Science and Mathematics, and try to explore the concepts in various phenomena and contexts. Additionally, SFTP stresses on learning outside of the classroom which is more practical and significant in promoting meaningful and excitement in learning. The modules for Science and Mathematics were written based on the theme of "Fun in learning Science and Mathematics". By using the school syllabus as a guideline, the modules were created in order to strengthen students' conceptual knowledge in Science and Mathematics as well as to emphasise its applications in students' everyday life.

The implementation of the training program took place in four phases: (1) Training - the STEM facilitators were equipped with the necessary skills to facilitate the STEM activities as well as help them to understand the STEM modules, (2) Execution in the real setting – the STEM facilitators were given a real platform to apply the knowledge and skills they have gained from the training. This was conducted with school students at various ages and levels, (3) Reflection – through discussion and post mortem, the trainers highlighted the aspects that the facilitators were lacking or needed improvement. Similarly, the facilitators reflected on their skills in handling the activities individually as well as doing peer evaluation which required them to point out the strengths and weaknesses of the fellow facilitators, (4) Re-train – based on the analysis and findings conducted in the reflection stage, the trainers planned the necessary training to help the facilitators to improve on the respective areas. Additionally, the re-training stage also focused on refreshing the facilitators' understanding of the modules in the upcoming activities.

Since SFTP was set up, there has been an increasing number of students from the Faculty of Education UiTM who had enrolled as facilitators for the program. Each of them have different reasons to participate in SFTP but the main reason seems to be the need to improve themselves as future teachers. This situation, to a certain extent, has initiated the researchers to look into the matter closely and carry out a formal investigation on the impacts of SFTP on the participants' personal development as future teachers. Therefore, the researchers had conducted a study with the following objectives: (1) to find out the perceptions of Science and Mathematics pre-service teachers on SFTP, (2) to examine the impacts of involvement in SFTP on Science and Mathematics pre-service teachers' personal growth as future teachers.

2. Methodology

This study employed a mixed methods design approach as the data collection procedures involved both quantitative and qualitative methods. The population of the study was the group of facilitators who had joined the programme and had gone through all the four phases of SFTP. The number of samples used for each method was different. A total of 125 samples were selected by using stratified random sampling to answer a short survey which consisted of two sections; Section A: Demographic background of the respondents, and Section B: The respondents' perceptions after participating in SFTP). The survey used a Likert scale which required the respondents to rate their perception on each statement based on scale 1 (Strongly Disagree) to 10 (Strongly Agree). The researchers adapted the items of the survey from Zeki Aksu, Mustafa Metin and Alper Cihan Konyalioglu (2014) in order to

gather the respondents' perceptions. The reliability of the instrument used was determined by Cronbach's alpha coefficient = 0.944 > 0.6. indicating that the items used are highly reliable. Additionally, the researchers conveniently selected 6 pre-service teachers (3 respondents from the Science program and another 3 from the Mathematics program) to be involved in a semi-structured group interview. A set of predetermined questions were prepared to obtain the respondents' views on the impacts of SFTP on their personal development as future teachers. The semi-structured interviews allowed the researchers to probe related questions in order to elicit the respondents to answer a specific issue in greater detail. The interview lasted for 35 minutes and the transcriptions of the interview were analysed thematically.

3. Findings

The reporting of the findings of this study herein will be in accordance to the objectives of the study as the followings:

3.1 The Perceptions of Pre-Service Science and Mathematics Teachers on SFTP

3.1.1 Distribution of the respondents

Table 3.1.1a: The Distribution of the Respondents by Program

Program	Frequency	Percentage (%)
Mathematics	60	48.0
Science	65	52.0
Total	**125**	**100.0**

Table 3.1.1a shows the distribution of the respondents by program. It indicates out of 91 respondents, 60 (48%) respondents were from the Mathematics program and 65 (52%) respondents were from the Science program.

Table 3.1.1b: The Distribution of the Respondents by Semester

Semester	Frequency	Percentage (%)
Semester 5	24	19.2
Semester 6	28	22.4
Semester 7	20	16
Semester 8	31	24.8
Graduated	22	17.6
Total	**125**	**100.0**

Table 3.1.1b shows the distribution of the respondents by semester. It indicates out of 125 respondents, the highest respondents came from semester 8 which is 31 (24.8%) followed by Semester 6 students, 28 (22.4%), Semester 5, 24 (19.2%), Graduated students, 22 (17.6%) and Semester 7, 20 (16%).

3.1.2 Respondents' Perception after Participating in SFTP

Table 3.1.2 shows overall results for respondent's perception toward SFTP (Mean=8.5124, SD=0.8277). This indicates that most of the respondents have a high positive perception toward the program.

Table 3.1.2: Respondents' Perception after Participating in SFTP

No.	Items	Mean	Std. Deviation
1.	My involvement in SFTP makes me clear of the roles of facilitator in learning	8.67	.883
2.	I improve my soft skills through my involvement in SFTP	8.63	.877
3.	Discussion and carrying out the activities in SFTP enhance my communication skills	8.62	.963
4.	My involvement in SFTP helps me to be more reflective on the aspects I need to improve as a future teacher	8.60	1.021
5.	I become more aware of what it takes to deliver the content effectively through my involvement in SFTP	8.46	.981
6.	SFTP helps me to handle students with different attitudes and abilities	8.42	1.055
7.	I become more flexible and improve my skills in time management by handling activities in SFTP	8.30	.983
8.	I am more confident to carry out any activities related to Science/Mathematics	8.41	1.033
	Overall	**8.5124**	**.82770**

(Note: 1 = Strongly Disagree, 10 = Strongly Agree)

Item 1, 'My involvement in SFTP makes me clear of the roles of facilitator in learning (Mean=8.67, SD=0.883) shows that most of the respondents have a better understanding of the roles and functions of facilitators. The mean for item 2, 'I improve my soft skills through my involvement in SFTP' (Mean=8.63, SD=0.877) and item 3, 'Discussion and carrying out the activities in SFTP enhance my communication skills' (Mean=8.62, SD=0.963). This indicates that most of respondents agreed that they had improved their communication. For item 4, 'My involvement in SFTP helps me to be more reflective on the aspects I need to improve as a future teacher (Mean=8.60, SD=1.021) and item 5, I become more aware of what it takes to deliver the content effectively through my involvement in SFTP' (Mean=8.46, SD=0.981), both items show the respondents had become more aware of their weaknesses and what they needed to do to improve, the results also showed that the respondents know what are important aspects that need to be considered to deliver a lesson effectively. Item 6, 'SFTP helps me to handle students with different attitudes and abilities' (Mean=8.42, SD=1.055) and item 7, 'I become more flexible and improve my skills in time management by handling activities in SFTP' (Mean=8.30, SD=0.983) has high mean thus indicating that the respondents believe that SFTP has helped them to be flexible as well as improved their skills in managing the students and time wisely. Lastly, item 8, 'I am more confident to carry out any activities related to Science/Mathematics' (Mean=8.41, SD=1.033) reflects that the respondents have better self-confidence to execute the activities related to their area of study.

3.1.3 Analysis of Significant Difference on Pre-Service Teachers' Perception between Academic Programs after participating in SFTP

The hypothesis to be tested are:
H_0: There is no significant difference in pre-service teachers' perception between academic programs after participating in SFTP.
H_1: There is a significant difference in pre-service teachers' perception between academic programs after participating in SFTP.

As shown in Table 3.1.3a, the mean of respondents' perception from the Mathematics program after participating in SFTP (Mean=9.44, SD=0.414) was equal to the mean of respondents' perception from Science programs (Mean=9.58, SD=0.296). The normality of the data was tested by using Kolmogorov-Smirnov test and found to be normally distributed, D(124)=0.047, p=0.2>0.05. Therefore, an independent sample t-test was conducted in order to determine the significant difference.

Table 3.1.3a: The Descriptive Statistic of Respondents' Perception towards SFTP by Academic Programs

	Course	N	Mean	Std. Deviation
Perception	Mathematics	60	9.44	0.414
	Science	65	9.58	0.296

The independent sample t-test in table 3.1.3b shows that there was no significant difference between pre-service teacher's perception from Science and Mathematics programs after participating in SFTP, (t=-0.097, df=89, p-value=0.923 > 0.05). Therefore, there is no significant difference on the respondents' perception between the above-mentioned academic programs. The results reflect that SFTP was suitable for the pre-service teachers from both programs.

Table 3.1.3b: Independent Sample t-test of Respondents' Perception towards SFTP by Academic Program

		Levene's Test for Equality of Variances		t-test for Equality of Means		
		F	Sig.	t	df	Sig. (2-tailed)
Perception	Equal variances assumed	1.200	.276	-.097	123	0.923
	Equal variances not assumed			-.108	113.9	0.914

3.1.4 Analysis of Significant Difference between the Respondents from Different Semesters on their Perception After Participating in SFTP

The hypothesis to be tested are:
H_0: There is no significant difference between respondents from different semesters on their perception after participating in SFTP.
H_1: There is a significant difference between respondents from different semesters on their perception after participating in SFTP.

As shown in Table 3.1.4a, the mean of respondents' perception for semester 6 after participating in SFTP (Mean=9.4875, SD=0.13756) was the highest among the means of respondents from other semesters. In order to determine the significant difference, an ANOVA test was conducted.

Table 3.1.4a: The Descriptive Statistics of Respondents' Perception towards SFTP by Semester

	N	Mean	Std. Deviation
Semester 5	24	9.4091	.28554
Semester 6	28	9.4875	.13756
Semester 7	20	9.4375	.25282
Semester 8	31	9.4722	.31638
Graduated	22	9.3750	.59261
Total	**125**	**9.4382**	**.37610**

The F test as shown in table 3.1.4b reveals there is no significant difference between the pre-service teachers' perceptions from different semesters after participating in SFTP ($F(4,86)=0.279$, p-value$=0.891 > 0.05$). Thus, the results indicate that H_0 is accepted.

Table 3.1.4b: ANOVA Test of Respondents' Perception towards SFTP by Semester

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	0.163	4	.041	.279	.891
Within Groups	12.567	120	.146		
Total	**12.730**	**124**			

3.2 The Impacts of Involvement in SFTP on Science and Mathematics Pre-Service Teachers' Personal Growth as Future Teachers

The views of the pre-service teachers who were involved in SFTP with regard to their personal growth were determined through semi-structured group interviews. The six samples involved in the process herein will be mentioned as A, B, C (from Science programs) and D, E and F (from Mathematics program). Respondent D was in the second year, respondent A and E were in the third year while respondent B, C and F were in the final year. The majority of the respondents were from semester 5 and above. The findings of the study will be discussed in themes which subsequently will be consolidated to attain the objective of the study.

3.2.1 Reasons to be involved in SFTP

It is imperative for the researchers to find out the reason(s) for the respondents to be involved in SFTP. The justification made by the respondents will be used by the researcher to determine the factor that has driven them to participate in the programme as well as to gauge their determination and motivation. When the question was asked to the respondents, the majority of them highlighted their need to improve on their skills as future teachers. Collectively, from the responses analysed, the respondents mentioned that they were not really confident to communicate in front of public, handle crowds/students, deliver knowledge and to conduct activities that are deemed to be fun. The notions highlighted by the respondents can be deduced by the researchers as more towards negative rather than positive. However, following the self-doubt, the respondents are determined to improve on the aspects that they were lacking in by signing up for the training program. They believed that SFTP could be a platform that was deemed as dynamic for them to learn and grow. The following excerpts relate to the findings:

"I think learn in the class will not enough to brush up my skills, I have so much to learn, I am not that confident to speak in front of people and it is hard for me to explain Science concept to my friends…."

Respondent A

".....I know in order to be a good teacher requires me to explore outside of my comfort zone, confident is not really my thing, I sometimes have doubt whether I can really teach well in class, handling students, managing activities – a very little idea I have about it...."

Respondent E

"I envy people who can talk well, I always have problem to engage with the audience when doing my presentation in class.....sometimes I wonder how to plan activity that can attract my students later, especially in Math...."

Respondent D

"I believe by joining a facilitator program, I would be able to increase my self-esteem, really...I really want to perform better, I've tried but most of the time it didn't work for me.....this help me to decide that I should look for opportunity to improve..."

Respondent C

3.2.2 Experiences gained through STFP

The second theme under this objective was collated from the responses obtained when the respondents individually highlighted their personal experiences on the exposures and training they had in SFTP since the beginning of their involvement. The researchers asked each respondent to share whilst the rest were allowed to add related information based on the responses. The data under this theme were used by the researchers to link the impacts of the SFTP on the personal growth of the respondents. The following excerpts are related to the above-mentioned theme:

"...the facilitator training course taught me how to arrange my ideas, deliver my words, dealing with various emotions, use specific words to deal with specific group of learners, be more flexible and confident....and of course learning from the senior facilitators in the program was not difficult, the actual engagement with the school students gave both good and bad experiences, I learned every time I joined the program. I also learned how to teach Science and Mathematics to school students...."

Respondent B

"...I like the part when I got to learn to use my knowledge in Mathematics to design fun activity for school children. But it is not only Math that I have to understand, SFTP meant for Science and Math to be integrated in various activities. It was quite hard yet fun for me to re-learn Science...plus I learned how I can facilitate learning, aspects like interaction, engagement and questioning are being emphasized by the program..."

Respondent F

"In total I have went to 5 schools under SFTP, each time I got to learn new things i.e. crisis management especially...the lecturers guided us in group or through one to one coaching, be it method to conduct activity, handling students, questioning techniques, elicit students' curiosity and how to make learning fun....we learned how to gather students' responses, rephrase what they said, reiterate important points and so on....it's all taught in the training course, every time we went to the field we practice..."

Respondent C

Based on the analysis made, the researchers noted that most of the respondents denoted similar responses in terms of the experiences they gained from the program. Among it are: (i) facilitating skills – asking and taking questions, stimulating curiosity, approaching specific groups of learners (ii) communication skills – rephrase responses, re-emphasizes points, varying tones in delivery (iii) crisis management – managing the unexpected while dealing with the students (iv) designing and delivering instructions, and (v) applying knowledge in Science and Mathematics when teaching the school students.

3.2.3 Impacts on the Personal Growth of Future Teachers

The analysis of the respondents' responses revealed that SFTP has imposed a significant impact on their individual growth as future teachers. By looking at the most frequent reasons given by most of the respondents, their involvement in SFTP has helped them to be more confident in terms of dealing with the audience and their subject matter. They found out that after a few times being in charge of school students as group facilitators, they had become more competent in terms of their delivery. Even though nervousness still exists, it is manageable compared to before they joined the program. They are no longer afraid to deliver concepts or use technical words in Science and Mathematics.

As for the communication skills aspect, most of the respondents joined SFTP at the beginning as they hoped they could learn to speak properly and convey their instructions with clear and presentable body gestures which was what they had found hard to do. Through SFTP, they were frequently reminded of what they were lacking in and were able to improve due to the continuous reflection. They are now more critical on what are deemed as effective and interesting delivery and what are considered not. They also noted that SFTP has helped them to extend their facilitation skills that is pertinent for them as a future teacher. Some of them said that, being a facilitator has broadened their horizon on another role that should be played by teachers rather than hundred percent focusing only on teaching. They realized that it is also important to engage with students while teaching through various means. Teaching without engagement will cause students to lose their interest or easily be distracted. By tracing back the reasons for them to be involved in SFTP, most of them agreed that SFTP has fulfilled the reasons and to some extent helped them to grow as future teachers.

4. Conclusion

It can be concluded that the pre-service Science and Mathematics teachers who had joined the STEM Facilitator Training Program have high positive perceptions towards the programme. There is no significant difference in the respondents' perception between the above-mentioned academic programs. This shows that the training programme was suitable for the pre-service teachers from both academic programmes. Regardless of their semester, the results indicate that there is no difference in terms of their perception after participating in the programme. In terms of the reasons for the pre-service teachers to join the programme, most of them see SFTP as a good platform for them to expand their ability as future teachers and to have real experience to deal with school students. What they wanted at the beginning of SFTP is to learn and grab the experience which they cannot get from the class. The study also reported that there were numerous skills and knowledge that the pre-service teachers gained throughout their involvement in SFTP. It is clear that SFTP has impacted the personal growth of the respondents as future teachers as they claimed to be more confident in delivering Science and Mathematics content, able to speak with better control and order, their instruction had improved and they know the important aspects needed to make an effective delivery in class. Overall they believe SFTP has helped them to improve. It is hoped that the program will be further developed and provide more comprehensive training to future STEM teachers to bring out more positive attributes of the future teachers which can indirectly contribute to the betterment of quality of education in Malaysia.

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