Training of Trainers Stem Build Program for Primary Science Teachers: An Initiative Towards Stem Education In School

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Abstract

STEM education in Malaysia is still in its infancy and initiatives to increase STEM field participation were outlined in the Malaysian Blueprint 2013-20125. STEM initiatives is a continuous process starting from preschool until tertiary level to ensure participation in the STEM fields hence providing STEM workforce. Therefore, it is necessary for teachers to be equipped with knowledge and teaching approach for STEM education especially from primary school because this is the foundation and build connection science with the real life situation. This is to ensure that the mindset towards STEM fields can be cultivated and sown from early schooling level. Primary science teachers were given a three phase training program to on STEM pedagogical approach in implementing STEM activities in school. Thus, this paper will share experiences of how the training was implemented and the impact obtained by the teachers readinessn to implement STEM education in primary schools.teachers showed effort and confidence to carry out the activity but needs more training on the STEM pedagogical approach.

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Keywords : STEM education, STEM pedagogical approach, training of trainers

1. Introduction

STEM education is fast becoming the new curriculum to develop and increase human capital participation in STEM fields all over the world. Malaysia is also taking up the initiatives through the Malaysian Blueprint 2013-20125. Due to, participations of students in STEM fields are declining from 2011(45% in the science stream) [12] until now 2016 (29%). This can be traced back to their enrolment in schools showing that the percentage of lower secondary students qualify but not taking science stream has increased to approximately 15%.thus the enrolment in STEM fields in upper secondary level were only 35% [12]. New approach to the problem points towards STEM education in strenghtening science related fields approach and initiatives in schools. But the focus should start earlier in schooling years that is primary students.

2. Problem Statement

Students in primary schools need to develop conceptual understandings and inquiry abilities to be problem solvers and productive citizen. This can be achieve through effective science teaching which stress on engaging in and learning about scientific practice[1]. Inquiry can be inculcate by asking and answering scientific questions, constructing explanations using evidence to support claims, and communicating and justifying findings. Young children need support to engage in sophisticated scientific practices and develop deep understandings of appropriate science concepts [11]. There was continuous decline in academic performance in Malaysia due to teachers focused on finishing the syllabus [8][13][15]. Almost 80% of teachers dominated classroom instruction by talking and asking simple questions[3].
Early engineering was found to be suitable to encouraged primary students due to the nature of problem solving skills development among children is related to ability to use scientific thinking .Early engineering also promotes critical intelligence [6][7] and intellectual traits. Past research suggest that primary students are able to reason better through ‘do and see’ approach in early engineering .

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Malaysia needs at least 500,000 children by 2020 who can think intellectually to continue the mission of becoming a developed nation [9]. In order to increase the total number of children to take up science a carefully studied plan needs to be implemented starting from primary school. STEM education in schools through planned and consistent activity should be implemented in schools as after school programs. In order to do this, teachers need to be given training in the STEM Pedagogical approach, STEM activities and the concept of STEM education. This is a change from the normal practice in schools of teaching science. Teachers and organisation managers need to change for this to happen. Thus, the Early Engineering Training of Trainers Program was carried out to address this. Teachers need to embrace this change in order for the plan to be successful. For a change to occur teachers must be willing to change to avoid conflicts that might stunt the intended change [7][4] . Individuals' acceptance for change depend greatly on the particular change that the indivual have to do and how they will be effected by it [5][4]10].
This paper will share how the teachers perceive change in terms of appropriateness, management support, self-efficacy and personal valence in order to indicate their readiness to carry out STEM education in school.

3. The Early Engineering Training of Trainers program

This program was developed especially for primary STEM teachers. The modules were developed based on 3 principles; Integration with the school science curriculum; Continuous involvement with the community and institution; and Connection with secondary education. The content of the module was based on 3 themes in the Malaysian primary science curriculum a) life science (energy); b) Physical science (urbanisation); c) technology and sustainability (transportation). The main feature in the module is the instructional design which follows the 'engineering design process' (Figure 1). The underpinning theories behind STEM education is 'constructivism' by Piaget and 'constructionism' by Pappert. Piaget and Papert are both **constructivists**. They both view children as builders of their own cognitive knowledge; that is as personal experience to be constructed. STEM pedagogical approach should involve "engineering design" as a basic for creating connections to concepts from mathematics or science (or both) (Sanders 2009).

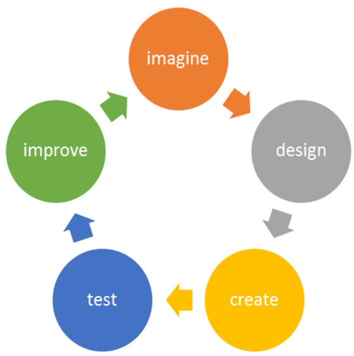

Figure 1: Engineering Design Process

The program was carried out in four phases (Figure 2). The first phase is the knowledge transfer phase; two modules were given to 25 teachers in a training of trainers program. These teachers came from 25 different schools. This training involved theory and hands-on activities in the first part and teachers were then instructed to carry out the activities in their schools and are being monitored by their district education department and from University of Malaya (UM) as the training provider. During the monitoring phase, the program team from UM will observe and give consultation to the teachers. These teachers are now only in the first two phases. The third module will commenced after the school based activity followed by the STEM camp. Throughout the program evaluation will be done periodically to measure the impact of the program towards the teachers and students. The first phase of the evaluation would be the readiness of the teachers to carry the Early Engineering activities in school

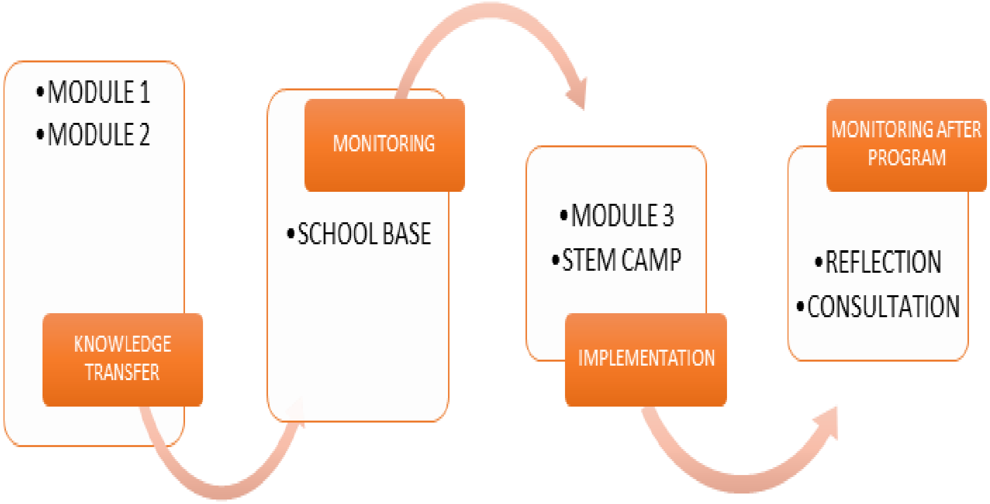

Figure 2: Implementation Process

The participants for the program were 25 teachers from 20 different schools in the district of Keramat. All the teachers are teaching science and science optionists. Their experience varies with 20% have been teaching below 5 years, 25% between 6-10 years, 25% between 11-5 years and 30% more than 15 years. All 25 teachers went through an Early Engineering Program (training of trainers) consisting of three modules. The three modules are Energy, Water and Sustainable Development. This program was developed based on three STEM principle; a) Integration of STEM with the School Science Curriculum; b) continuous involvement of the community and industry; and c) connection with secondary science education. Projects in the module were developed based on three themes in the primary science curriculum; a) life science (energy and water); b) physical science (urbanization) and c) technology and sustainable living (transportation). In every module, it follows four constructs; a) theory and concept; b) activity; c) project design and develop (engineering design process); and d) showcase. Though for this paper, the results shows the assessment of the teachers after undergoing 2 modules. The third module will be given after a 6 months interval for the teachers to carry it out at their school.

4. Methodology

A pre-exposure to the concept of STEM and pedagogical approach was given in a one day training before commencing to the modules. Module 1 and 2 is on how to carry out the content of the module To date, module 1 and 2 have been delivered and the teachers are in the second phase of the program whereby they have to carry out at least one activity with the students in their schools. After training, teachers were given a 16 item readiness for change scale and all 20 teachers were observed while doing the activities.

Readiness for change was measured using Holt et al.'s (2007) readiness for change scale. The scale is based on their theoretical framework and reflects that readiness for change is a multi-dimensional construct. The measure includes items on appropriateness, social support, self efficacy for change, and personal valence. participants were asked to indicate on a 5-point Likert scale (1 = strongly disagree and 5 = strongly agree) the extent to which they agreed or disagreed with each of the statements. All questionnaires had been translated in Bahasa Melayu and distributed to all participants.

5. Results and discussion

The statistical descriptions of variables for the group included mean, standard deviation, minimum, maximum and Cohen's d was displayed below. The data shows pre-appropriateness (*M*=3.77, *SD*=0.66) post-appropriateness (*M*=4.22, *SD*=0.80) and (*d*=0.06), pre-managerial support (*M*=2.74, *SD*=0.69) post-managerial support (*M* =3.55, *SD*=0.70) and (*d*=1.20), pre- self-efficacy (*M*=3.92, *SD*=0.65) post- self-efficacy (*M*=4.21, *SD*=0.83) and (*d*=0.36) and lastly, pre- personal valence (*M*=3.68, *SD*=0.67) post- personel valance (*M*=3.74, *SD*=0.61) and (*d*=0.08). Table 1 is the descriptive statistic for the group of teachers.

Table 1 : Descriptive statistics

Variable	N	Minimum	Maximum	Mean	SD	Cohen's d
Pre-appropriateness	25	3.00	5.00	3.77	0.66	0.06
Post-appropriateness	25	3.80	5.00	4.22	0.80	
Pre-managerial support	25	2.00	5.00	2.74	0.69	1.20
Post- managerial support	25	2.40	5.00	3.55	0.70	
Pre-self efficacy	25	3.00	5.00	3.92	0.65	0.36
Post-self efficacy	25	2.80	5.00	4.21	0.83	
Pre-personal valence	25	2.50	5.00	3.68	0.67	0.08
Post-personal valence	25	2.75	4.75	3.74	0.61	

The results showed that in all aspect of readiness teachers show an increase in their perception on the approprianess of the change, managerial support that they get from their administrators, their own efficacy to carry out the STEM activity and also the benefit for them to take part in the change of approach to science teaching through STEM. Observations during the activities were also recorded and field notes were taken and analyze. The finding of the observation showed teachers were quite engrossed in the activities and trying their very best to understanding the engineering design process. The STEM pedagogical approach for each activities and project was introduced which encompasses the need to enhance and prepare with their knowledge of the concept being used and poing appropriate questions to stimulate and motivate the innovative and inventive thinking amongst the participants.

5. Conclusion

This Early Engineering TOT for primary STEM teachers was seen to be able to give positive impact to the teachers and they showed interest and motivated to implement it at their schools. The next phase of th program will be monitoring and consultation for the teachers when they carry out the program in their own schools. For this program to be sustainable in future school management and MOE need to give their support for them to continue this program.

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