STEM Village: Promoting and Spreading Awareness about STEM to Families and Society

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In 21st century, STEM are sought-after fields that are significant in developing a country. The advancement of a nation is often judged by their achievement in STEM and consequently, the quality of their STEM workforce. However, the effort to support and sustain this endeavor rarely go beyond school classroom. Families, as the nucleus of civilization and basic social unit of society, have strong potential as a medium to promote STEM. This session talks about STEM Village, a project by SEAMEO QITEP in Mathematics, to create a series of out-of-school-time activities designed for children and families, to promote and spread awareness of STEM through engaging, low-cost, context-suitable, and relevant for daily life STEM activities.

Keywords: STEM, family, extracurricular

A. Introduction

STEM has been the major buzzword for quite some time in Indonesian education. Even though there is no any regulation regarding adopting STEM officially into the national curriculum, various STEM-related educational agenda have emerged from diverse educational institutions i.e. seminar, workshop, and the like. In mid-2018, the Ministry of Education held a nation-wide training for Science and Mathematics middle school teachers, aimed to introduce STEM education and familiarize them with applying it in their teaching routine.

However, the effort so far has been strictly confined to school setting. STEM lessons that are introduced to the teachers so far are designed for classroom application and strictly concerned with staying inside the curriculum lines. The teachers' concerns are also mostly revolved around assessment, subject content, and how well STEM education will help their students excel in national exam; giving insight that STEM education so far are viewed as an approach that strictly belongs to school environment.

This paper will discuss the potential of out-of-school STEM education program and the design for such program in Indonesian context.

B. Out of School STEM Activities

Educational program focused on STEM in out of school setting is not entirely new idea. In the United States, the birthplace of STEM as an educational approach, there is growing interest and investment in out-of-school-time STEM programs (Bevan *et al.*, 2010). Federal agencies and researchers have advocated the use of OST to support and supplement the knowledge the students learn in school. Aside from supporting formal learning, out-of-school

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STEM activities are also beneficial for female students and racial minority students (or both), which is a major agenda for US educational system. Because out-of-school-time activities are not strictly linked to school curriculum, these programs are easily customizable to fit students of certain needs, like female or racial minority students.

By default, out-of-school-time STEM activities are learning activities that occur outside of formal school setting, even though the formal definition of it take things further by describing it as personal, contextualized, and time-consuming (Dierking *et al.*, 2003). We also needs to make distinction between *structured* and *unstructured* out-of-school-time STEM activities (Dabney *et al.*, 2012). Structured activities are museum visits, afterschool club, mathematics competition, and the like, while unstructured activities are those that happen solely because of the students' personal interest e.g. tinkering with objects, doing experiment on their own, or researching things online. The out-of-school-time STEM activities described in this paper will be limited to the structured ones.

Even so, structured out-of-school-time STEM activities are still very versatile and open to a lot of options. It can be offered by established institution outside of school, like museums or national park; or offered by school as extracurricular activity. It can be conducted indoor or outdoor. The program can be designed to require continuous attendance over certain periods of time, or flexible participation instead, during which the students are free to decide according to their availability and interest. When it comes to knowledge, it can be focused on certain content domain or more towards general application of STEM in everyday life.

Despite its variation, there are several differences between out-of-school-time STEM activities and STEM activities within school setting (Bevan *et al.*, 2010). First, they tend to be less verbal and abstract. Out-of-school-time STEM activities are usually more tactile and built on sensory experiences with real-life resources (places, phenomena, data, and tools) that are often difficult to integrate into actual classroom. Second, they provide more ground for group or collaborative investigation, rather than individual learning activities. Students who are not doing well with collaborative learning in formal school setting, can learn to work with other in out-of-school setting. Third, because they are less confined within mandated curricular guidelines, the students can learn in a more flexible way that put their knowledge development first instead of merely doing well in exams. Time is usually the biggest obstacle for teachers in trying out experimental lessons, therefore out-of-school-time activities allow teachers and students to pursue ideas they find interesting, at their own pace. Last and not least, out-of-school-time activities are low-stakes (non-evaluative), they put less pressure for the students to be correct or to do well. This is especially important for the students who have been discouraged by conventional STEM environment e.g. school, either by being identified as non-competent or judged that STEM subjects are not 'suitable for them. This usually happens to girls, minority students, or socioeconomically disadvantaged students.

There are several reasons that make out-of-school time STEM activities worth considering. As STEM being popular educational jargon was started by the need for more competitive workforce in STEM fields, it is no wonder that programs focused on making the students more interested in STEM career are widely favored. The link between out-of-school-time STEM activities and STEM career choices are interest, which emphasizes curiosity and

the enjoyment of learning about a certain topics instead of achievement and test scores (Krapp, Hidi and Renninger, 1992). Based on the description of out-of-school-time STEM activities above, they ignite the students' interest in STEM fields, develop and expand their understanding, which leads to them to be more aware about the role of STEM career have in society (Bevan *et al.*, 2010). Research by Dabney et al. (2012) showed that participation in out-of-school-time STEM activities encourages students to pursue university majors in mathematics and science and to eventually select a career in a STEM-related area. The less strict confinement of school curriculum, less demand on formal assessment, and more emphasize on daily life application, all contributes to these factors.

National Research Council (2015) identified three criteria of successful out-of-school-time STEM programs, namely engaging, responsive, and make connections. These criteria are broken down into further, more detailed criterium, as laid down in the following diagram.

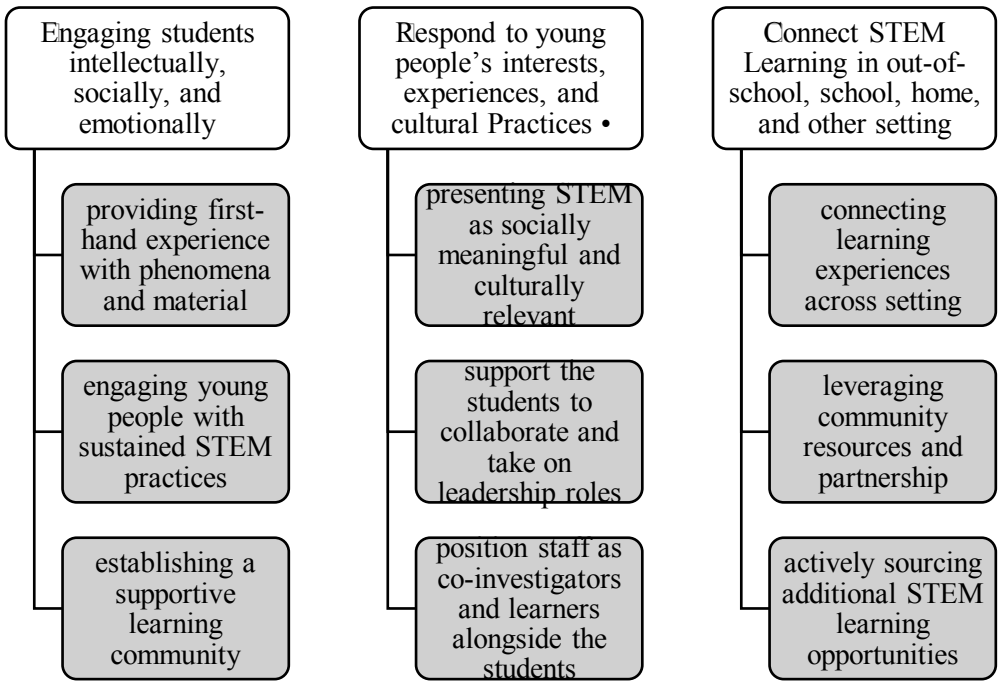

Figure 1 Criteria for successful out-of-school-time STEM programs

C. Family Involvement in Out-of-School-Time STEM Activities

One factor that argued by researchers as the main contributor in students' interest in STEM subjects is novel and engaging problems that are relevant to real-life situations (Dabney *et al.*, 2012). Other factor found to be pivotal in the development of the students' attitudes toward STEM subjects is parental involvement (George and Kaplan, 1997). STEM learning ecosystem model by L.S. Liben (National Research Council, 2015) also identify home, neighborhood, and out-of-school experiences as being impactful to students' learning development as school (Figure 2).

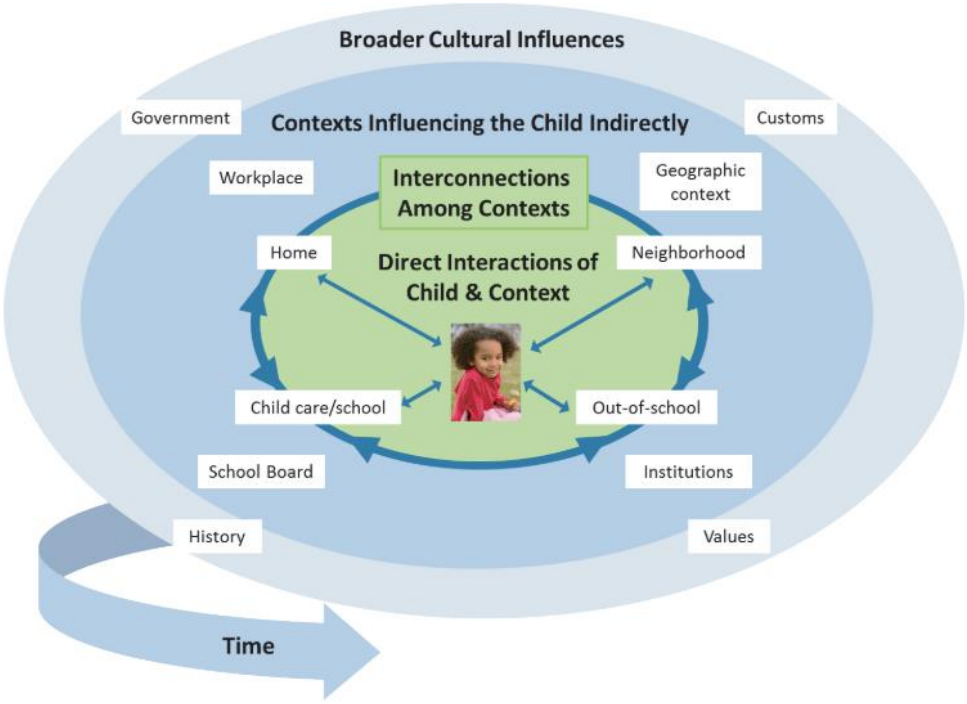

Figure 2 STEM learning ecosystem model (National Research Council, 2015)

Based on the result of these studies, community and home-based out-of-school-time STEM activities is inevitably a promising path for future researchers in this area.

D. STEM Village

We decide to design out-of-school-time STEM learning activities involving families as part of the program of SEAMEO QITEP in Mathematics, called STEM Village (*Kampung STEM*). Children and mothers from communities around the office can participate voluntarily in STEM program held once a week with different topics and activities. The project is still in starting phase and on-going, with more than twelve mothers and around ten kids attending every session.

Although it is still in a very initial phase, this program attempted to apply the principal identified as contributor of successful out-of-school-time STEM activities. First, the parental involvement is integral to the program, even though only mothers are participating so far and the activities are separate with the children. Second, the contexts used in every activity are socioeconomically and culturally relevant. This does not mean the topics only stays within the zone that are familiar for the students; we also attempt to introduce global issues to their horizon, however we made sure for the learning process to be reachable from their starting point, either the local context or the students' content knowledge. The materials are made sure to be low in cost and easy to be acquired.

Third, the activities provide practical, tactile, and hands-on experience for participants, as well as chance to work collaboratively with others. Last but not least, the program is conducted in partnership with local community. Especially for the mothers, we made sure to incorporate the element of entrepreneurship to the activities. Aside from making it more engaging, it also

opens possibilities for supporting family's economy. Above all, the overarching aim of the whole program is to introduce and bring awareness of STEM, in the hope of developing positive attitude and interest toward STEM subjects.

Below are some examples of activities conducted in this program.

a. Tenun ikat (tie-dye)

Textile is a huge part of Indonesian culture, which resulted in a variety of traditional textile coloring method. These traditional methods commonly involve *resist* technique, namely different ways to prevent color to reach fabric, thus creating patterns. One of the most renowned are *batik*, whose resist method is by drawing pattern over the fabric with wax, hence preventing color from seeping through the fabric. *Batik* is one of the most prized cultural heritage of Indonesia and is an integral part of the society, from informal daily life to formal and luxurious events.

However, there are other coloring methods that are just as interesting but less explored, for example *tenun ikat* or commonly known as tye-dye. The resist methods involved here is by tying the fabric, therefore creating resistance that prevent color to the fabric. Different tying methods will result in different patterns and combination of color.

Tye-dye is a potential STEM activities because the science and mathematics involved in making the pattern and mixing the colors, which can be either artificial or natural. From the technology perspective, tye-dye method is a technology invented by human in a pursuit of easier cloth-dying method. Meanwhile, the engineering aspects comes in the form of creating different patterns and color combination.

Aside from promoting STEM, tye-dye is also an excellent entrepreneurial activity. The tye-dye fabric and clothes produced by the mothers have been exhibited in several local exhibitions, which has been received very positively by potential customers.

b. Ecoprint

Aside from tye-dye, other coloring techniques which is also less explored is ecoprint. This coloring method strictly uses natural color pigment found in plant body part, for example leaves and flowers. The leaves and flowers are laid down on between two sheets of white fabric, hit repeatedly to break and release the color pigment. The fabrics are then rolled into a small fold, tied with rope, and steamed or ironed. This process will produce the stamps of leave or flower on the fabric, creating interesting natural pattern.

The color pigmentation of leaves and flower will be an excellent ground to learn about plant. From the perspective of technology, ecoprint in itself is a technology invented by human for easier cloth-dying method, while the engineering aspect is the creation of different patterns and color combination.

Just like tye-dye, ecoprint is also an excellent entrepreneurial activity. The ecoprint fabric and clothes produced by the mothers have been presented in several local exhibitions, which has been received very positively by potential customers.

c. Wiggle bot

The wiggle bot is the activity for the students. This activity involves making simple robot from objects around them. The produce is a simple robot with pens tied to a body made from

cups and spinning arms moved by dynamo/motor, which will create interesting pattern on paper.

Wiggle bot activity aims to introduce the simple principle of robotic, which is that no matter how complicated, a robot needs power and motor move. Today robotic technology is used in various fields with different level of complication. We attempt to introduce the students with this technology by starting with something simple and can be easily acquired from everyday life object.

E. Discussion and Conclusion

STEM village so far has shown potential to be a platform for families to not only explore STEM subjects and its relevance in solving problems in real life, but also to encourage STEM career choice for the children and to provide entrepreneurial activities for the mothers. This project brings potential to promote STEM not only in school setting, but also to other contexts that are close to children's life, for example home, families, and neighborhood.

However, as STEM Village project is still in a very initial stage, there are several concerns that we need to address. The first one is the topics. Even though out-of-school-time STEM program is not aimed to adhere to certain school curriculum, we still need to select and establish a sequence of topics that can be used as guidance in conducting STEM village. Second is evaluation. We need to establish a way to assess and evaluate the effectiveness of the program. The last but not least is scalability. As we hope for STEM village project to reach larger audience, there is a need for a reliable method to scale it for different setting or number of participants.

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