

Designing science, technology, engineering and mathematics (STEM) competition during COVID-19 pandemic

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Keywords: STEM, online activity, COVID-19 pandemic

ABSTRACT –Suspension of face-to-face instruction in schools during the COVID-19 pandemic has led to limitation of STEM activities among school pupils. This study aim is to design an effective STEM online competition to give opportunity to children explore STEM education even without face-to-face training session. The competition focuses on Scratch Programming, implemented in fully online-mode for all phases, to avoid any harm due to the pandemic. The designed competition is evaluated based on participant analysis, competition information broadcasting method and adult involvement distribution. Results show that, the designed competition affectively encourages children engaging to STEM activities. 69% of the participated children without any experience of Scratch Programming able to do the competition task just by referring to resources that provided in the competition official Facebook and another related open sources.

1. INTRODUCTION

STEM (Science, Technology, Engineering, Mathematic) Education has been recognized as essential in developing children with problem solving skill, i.e., skills to succeed and adapt to this increasingly complex, changing, technological world [1]. By having this skill, the children are intended to lead to innovation necessary to sustain our economy. In Malaysia, STEM education has been implemented using co-curriculum activities, such as robotic camp, innovation courses, mathematic quizzes, and related competitions [2][3].

On the other hand, the world has been hit by the COVID-19 pandemic since December 2021, and up until now it is still spreading and will become as an endemic disease, where face-to-face activities are still limited to certain activities [4]. The pandemic that has been stated as very contagious disease has affected various aspect of people life including academic and children growth [5]. It has been reported that in all over the world schools have been closed, leads to a scenario where children need to learn from home [6]. Most of academic and school activities need to done using online method, to avoid physical contact among school communities that might increase COVID-19 cases. In Malaysia, the COVID-19 also affects STEM related activities, since it is normally done using face-to-face mode. Previously, most of the STEM activities involved onsite training and competition.

The aim of this study is to evaluate effectiveness of the proposed Online STEM Competition Design during COVID-19 Pandemic, in order to encourage children participating in STEM activity. In this competition, children with age range from 9 to 12 years old will be

given a task to develop a computer game or video animation using Scratch Programming. The competition activities are divided into four main phases: Promotions, Participants and Material Registration/Collection, Evaluation and Results Announcement. The designed competition involved three main entities: committee, participant, and evaluator.

In the next section, competition design and implementation phase will be discussed, where the detail of methods and strategies for each phase will be explained. The design and implementation will be discussed in Section 2, and evaluation results for the proposed design will be discussed in Section 3.

Table 1 Competition Information

Competition Name	CodeWar 2020
Target Participant	Primary School Student (Age 10-12 years old)
Organizer	Fakulti Teknologi Maklumat dan Komunikasi (FTMK), Universiti Teknikal Malaysia Melaka (UTeM)
Official social media	Facebook: CodeWarTerritory Instagram: http://instagram.com/CodeWarTerritory
Sponsor/Colaborator	Malaysia Space Agency (MySA) Ministry of Education (MoE)
Category	Computer Game, Animation Video
STEM Skill	Technology, Scratch Programming
Duration	Project Development: 1 Oct – 11 Nov 2021
Task	Evaluation: 12-20 Nov 2021 Participant needs to develop a computer game/ an animation based on related category
Evaluation Materials	Scratch file video presentation
Award and Prizes	Champion: RM500 with e-certificate 2 nd Place: RM300 with e-certificate 3 rd Place: RM100 with e-certificate All participants will receive e-certificate

2. DESIGN AND IMPLEMENTATION

The information of the competition is summarized in Table 1. The competition, named as CodeWar 2020 was opened to primary school students (Age 10-12 years old), organized by FTMK, UTeM. The competition was funded by Malaysia Space Agency (MySA) and supported by Malaysia Ministry of Education (MoE). In the competition, the participants need to develop a

computer game using Scratch programming. Along the game development process, the participants could refer any sources as their references, including examples, materials provided in codewars in official social media.

The implementation of the competition is divided into four phases described as follows:

- **Promotion Method**

The related competition materials are uploaded in the official Facebook as shown in Figure 1. Then, the instant messaging applications are used to spread the information. Only link is provided in the instant messaging application, so that the participant can only reach the latest and valid documents/materials/references provided by the organizer. This method is crucial to ensure the participant will take action based on valid instruction by the organizer. The participant can only contact the organizer by using official contact such as formal email and Facebook messaging.



Figure 1 Promotion and Related Information Posting in Official Facebook [7]

- **Participants Registration and Material Collection**

Participants' registration and Material Collection are done using Google Form. This is important to use well-known application, so that no technical guide is required to assist the participant on registration part. The organizer must focus on providing related materials/resources that required for task development such as examples of Scratch project,

open-source video editor for video presentation reference. Here, the participant needs to be registered by a mentor. In this competition we allow either parent or teacher as a mentor, which is only limited to teacher in previous on-site competition. This is because, it is predicted that the students will have very limited time to see their teachers due to school closing order by MoE to avoid COVID-19 affection

- **Evaluation**

The evaluation process is divided by two phases; phase 1 to identify top 5 participants in each category while phase 2 to identify the winner from the top 5 participants. In phase 1, 30 evaluators have been assigned to identify the top 5 participants. The evaluation process is done in asynchronous mode, where the evaluator will be given list of projects to be evaluated. Each participant is evaluated by 4 different evaluators, and the evaluator- participant mapping need to be randomly distributed to increase fairness evaluation process. Evaluators give mark based on rubric prepared by the organizer. All of this process in done using Google Form. In Phase 2, the evaluation is done using synchronous mode where four juries need to re-evaluate the top 5 participants to determine winners. The session was done using Webex platform, based on evaluation rubric prepared by the organizer.

- **Results Announcement.**

The result announcement was done through official Facebook posting (Figure 2) and the winner is informed using provided information during registration.



Figure 2 Winner Announcement in Official Facebook [8]

3. RESULT AND DISCUSSION

In this section, the effectiveness of the designed competition is analysed based on participant analysis,

competition information broadcasting method and adult involvement. The analysis is done based on 164 participants from various state in Malaysia. The participant distribution can be seen from Figure 3. We can see that most of the participant comes from Malacca State.

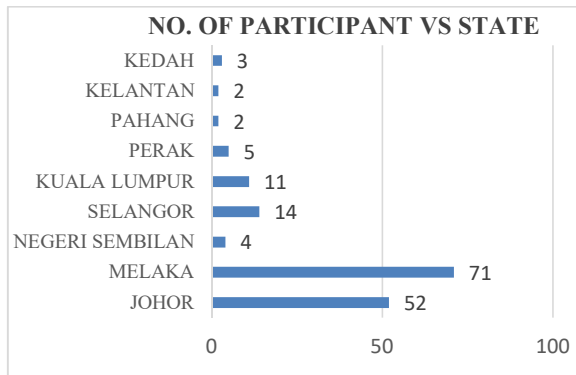


Figure 3 Participant from Various State

The main reason for this scenario is the organizer is centred in Malacca, which is FTMK, UTeM. This competition has been recognized by the MoE since 56.7% of the participation comes from primary school outside Malacca.

In Figure 4, we can see that 69% of the participant have no knowledge or do not have any experience on using Scratch programming. The unexperienced participant might try to explore Scratch Programming by referring links/source posted in Codewar Official Facebook and another open source. It seems that the participated students able to learn and have a new knowledge without attending face-to-face training session. Through the competition, students' participation on STEM activities can be done encouraged, without having activities that might increase COVID-19 cases.

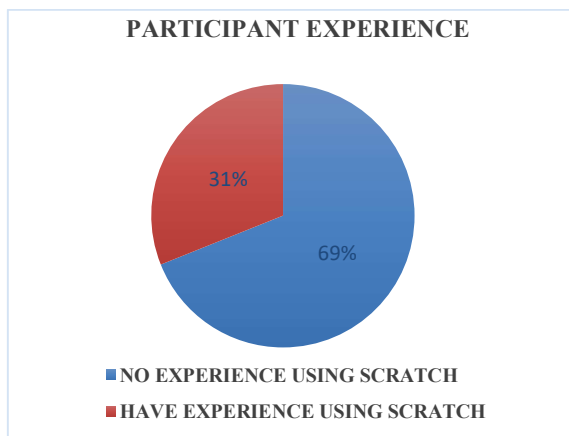


Figure 4 Participant Experiences/Knowledge about Scratch

As stated in Section 2, the promotion phase is implemented by using three main sources, which are instant messaging application (WhatsApp and Telegram), official media social network application (Facebook) and printing material. Figure 4 shows information source that

firstly enable to reach participant.

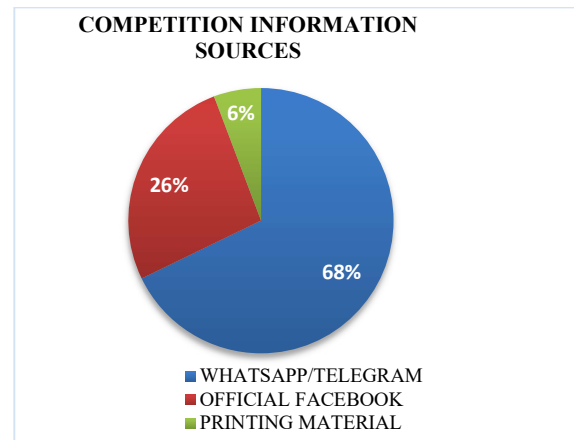


Figure 5 Competition's Information Sources

From Figure 5, 68% of participants firstly receive information from WhatsApp/Telegram, 26% from official Facebook, and 6% from printing material such as pamphlet. It can be concluded here, the promotion using instant messaging can reach the target faster compared to other method. However, using WhatsApp/Telegram solely could not be said as an effective method. The posting should be done an official Facebook and WhatApp/Telegram can be done to broadcast information inside the official Facebook. The combination of WhatsApp/Telegram with official Facebook will provide a better information to the participant. The method also can be efficiently implemented during COVID-19 pandemic because of all of the process can be done in individual space from anywhere.

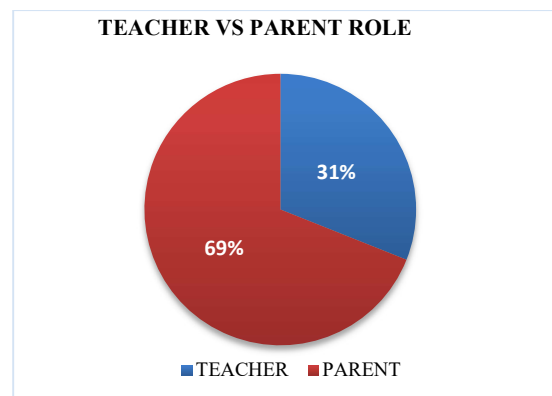


Figure 6 Adult Involvement as Mentor

Figure 6 shows adult involvement in participation. Adult is considered as a mentor to help student register, explore the how to develop scratch programming and solve the task given in the competition, using related sources. From the figure, 69% of the mentors are parent, while 31% are teachers. This occurs because, during COVID-19 pandemic, schools care closed, movement control order (MCO) is enforced, leads to difficulty for a teacher to meet and supervise his/her students. From the number, we can see that, parent involvement is important to ensure or to encourage children to participate, and

explore Scratch programming that fall under technology field, which is one of the STEM education components. To sustain STEM skill enrichment during pandemic it is recommended for a competition organizer to take the following consideration/recommendation:

- Use a website/ social media network application to upload related information
- Use instant messaging application to broadcast the information and help participant to reach the official website
- Design a simple submission method using a well - known open source such as Google Form
- Encourage adult involvement (teacher or parent) to guide students having a valid information and material for STEM activity.
- During pandemic situation, it is important to allow parent involvement since the MCO order will limit mentoring session by a teacher.
- Expand the participation to the upper level such as national or international since the information can be reached from anywhere.

4. CONCLUSIONS

Result illustrated that 69% of participants that have not experience in using Scratch Programming are able to solve the task based on resources shared in competition official Facebook and open source. Social media is the important element of competition management, while the participation of teachers and parents is a major factor in a STEM competition implementation (refer Figure 7). The information and sources posted in the official Facebook can be broadcasted to the target participant with the help of instant messaging application, such as WhatsApp and Telegram. On the other hand, parent involvement is important to ensure student participation in STEM activity during COVID-19 pandemic since teachers have a very limited chances to directly mentoring their students. From the results, it can be concluded that the proposed online STEM competition design can encourage students' participation in STEM activities during COVID-19 pandemic.

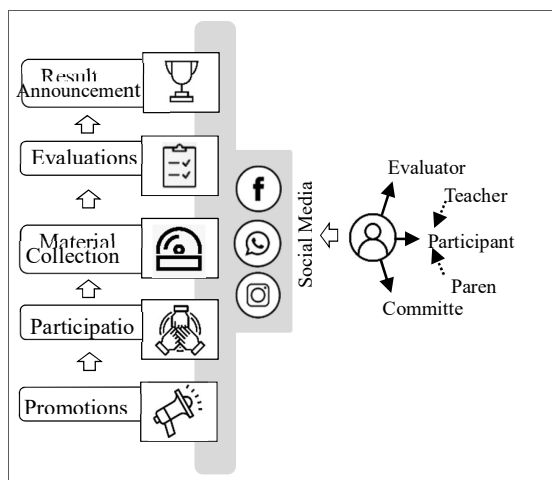


Figure 7 Competition Design

5. ACKNOWLEDGEMENT

The authors would like to thank the Information Security Forensics and Computer Networking Research Group (INSFORNET), Fakulti Teknologi Maklumat dan Komunikasi (FTMK), Universiti Teknikal Malaysia Melaka (UTeM).

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