An Evaluation on the Implementation and Outcome of a Webinar on Enhancing STEM Education through STEM Makerspace

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Received first draft 1 September 2021. Received reports from first and second reviewers (7 September 2021 and 4 October 2021). Received revised draft 30 November 2022. **Accepted** to publish 20 December 2022.

Abstract

Purpose and Research Question - Makerspace can be described as a physical place where participants can create and co-create knowledge as well as physical or digital products or a making mindset that can be applied to classrooms, homes, or other places. It can support the existing school-based curriculum such as STEM project-based learning or after school extracurricular activities. The Southeast Asia Ministers of Education Organisation (SEAMEO) Regional Center for Education in Science and Mathematics (RECSAM) organised a webinar entitled 'Enhancing STEM education through STEM Makerspace' with the goal of creating awareness about the role of STEM Makerspace in enhancing STEM education. This paper aims to describe the evaluation of the implementation process and the outcomes of this webinar.

Methodology – A combination of the qualitative and quantitative methods was used. Data were collected on the document to review the work process and online evaluation form.

Findings – The analysis of the online evaluation generally revealed that participants perceived the webinar's delivery positively. Besides, the evaluation of the outcomes of the webinar indicated the findings revealed participants' perceptions and needs regarding STEM makerspace.

Significance and Contribution in Line with Philosophy of LSM Journal - The findings contribute to the growing evidence on webinar effectiveness for delivering teachers' professional development programs. The evaluation of the outcomes helps make judgments and guides the selection of interventions for the STEM makerspace in the future.

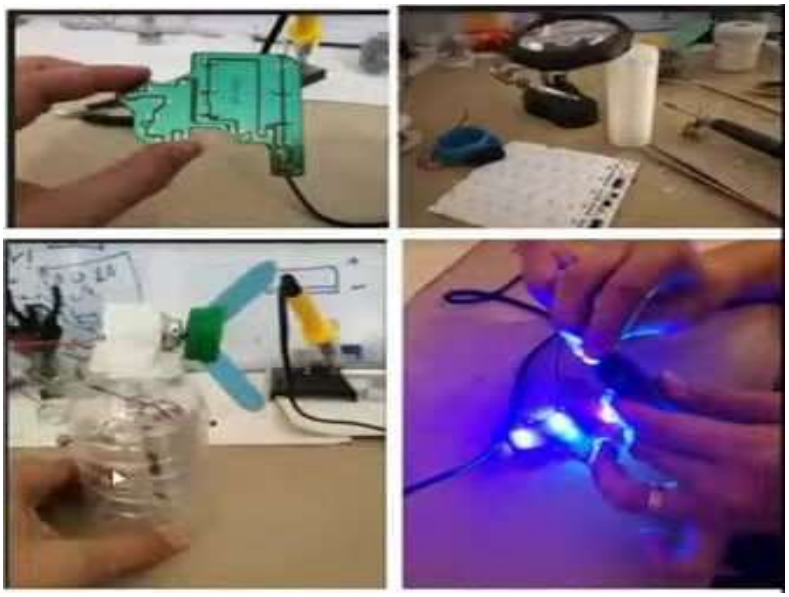
Keywords: Webinar evaluation; STEM Makerspace; STEM education; Process evaluation; Product evaluation

Introduction

Makerspace is a physical place where participants can create and co-create knowledge as well as physical or digital products (Martinez & Stager, 2019). It is a space with shared resources that can be used for projects of interest with the support of a maker community (Han et al, 2017; Oliver, 2016a). Among the types of making activities in makerspace are engineering, tinkering, circuitry,

technology, crafting, computer programming, woodworking and fibre artistry (Martinez & Stager, 2019). Some examples are illustrated in the following Figure 1.

Figure 1 Exemplary making activities in makerspace



However, Oliver (2016b) says that a makerspace is more about learning and activity than the physical space. It is about the making mindset applied to classrooms, homes, or other places. Therefore, the focus is not on converting a room into a designated makerspace but on a making environment that provides the potential for cross-curricular connections, collaboration, creativity, innovation, and learning (Martinez & Stager, 2019). Hence, all makerspace activities facilitate learning, transforming people from knowledgeable to knowledge creators (Han et al., 2017). Participants can explore various tools, materials, concepts, learning experiences, and disciplines that they may not have experienced before (Mersand, 2021) and develop critical thinking skills through problem-solving during the making process by engaging in hands-on activities. It also supports innovation and entrepreneurship essential for preparing individuals to face global challenges (Lindtner, 2015).

Mersand (2021) describes that the growing number of makerspaces, especially in the United States, may be related to students' need to promote STEM skills. This is because the maker activities can contribute to the acquisition of STEM-related skills such as problem-solving, innovation and 21st-century learning skills that arise from applying strategies in the engineering design process (Sen et al., 2018). To date, many of the makerspaces are commonly found in places such as public libraries or in non-formal education centers school making (Oliver, 2016a). It helps to enrich the school-day curriculum by bridging formal and informal learning (Oliver, 2016a). Makerspace can support the existing school-based curriculum in a few ways. For example, makerspace activities can be used in STEM project-based learning, especially in science and mathematics. Makerspace can also be planned and implemented as after-school extracurricular activities (Harron & Hughes, 2018).

Background and Objectives

Webinars are commonly applied in distance education and blended learning training programs (Gegenfurtner et al., 2020). For instance, Chiswell et al. (2018) conducted six webinars to educate health professionals and people affected by cancer. The online metrics and post-event survey analysis revealed that 90.1% of the participants indicated that the webinar content was relevant to their interests and needs. They concluded that webinars are effective, acceptable, and sustainable for delivering information and support for health professionals and people affected by cancer to reduce the impact of cancer. In the education field, Hoke et al. (2018) mentioned that webinars provide a viable method of instruction and education for school personnel interested in strategies for improving a school's wellness environment. However, further investigation is necessary to determine the best approach for promoting webinar engagement and relationships between webinar participation and positive changes in school wellness environments. A webinar is a practical way to deliver an interactive educational seminar given the current Covid-19 Pandemic situation whereby physical gathering is not allowed in many areas in the world. Besides, webinar technology is readily available and inexpensive compared to hosting a physical seminar. ~~It~~ webinar is relatively easier to schedule, conduct, manage and easily access participants from different parts of the world (Chiswell et al., 2018). Various organisations and institutions organised many education webinars to substitute the face-to-face seminars mainly for teachers' professional development. Thus, there is a need to evaluate these webinars to identify strengths and problems that need to be addressed to improve their effectiveness further.

Given the benefits of makerspace and the advantages of webinars, a two-hour webinar entitled 'Enhancing STEM Education through STEM Makerspace' was organized by the Southeast Asia Ministers of Education Organisation (SEAMEO) Regional Center for Education in Science and Mathematics (RECSAM)'. The main goal of the webinar was to create awareness about the role of STEM Makerspace in enhancing STEM education. Three speakers were invited to deliver a talk on these topics: (1) STEM Education in Southeast Asia; (2) STEM Makerspace in Schools; and (3) STEM Makerspace in the Community.

This webinar focused on introducing STEM Makerspace in integrated STEM education. Makerspaces are places where people create physical or digital products that allow potential cross-curricular integration, collaboration, creativity, innovation, and learning (Martinez & Stager, 2019). Makerspace can be classified according to its accessibility. Accessibility variations include (1) Open access; (2) Curriculum-based; (3) Scripted; or (4) any combination of the above. In open access, users are free to do what they want with the available tools and materials. In contrast, in a curriculum-based makerspace, users participate in activities aligned to a curriculum. In a scripted makerspace, a program director designs activities unrelated to any curriculum for users to participate (Mersand, 2021). Blackley et al. (2017) distinguished Makerspace Approach from the traditional makerspace in which they describe makerspace approach as space, resources, and opportunity required for a collective to make an artifact or product that is often unique to the maker yet can be based on a common theme and even a typical pattern. In the Makerspace approach, participants are organised into pre-determined communities, for example, students in a particular class, where they are provided with a base-level kit of materials. They are shown a completed

base-level and operational (as appropriate) artifact and are challenged to construct a similar artifact. Teachers serve as mentors to facilitate and scaffold the students to evaluate their artifact. They also enable to make aware the underlying science, technology, engineering, mathematics, or other concepts in line with curriculum documents. This makerspace approach seems to be similar to the curriculum-based makerspace described by Mersand (2021).

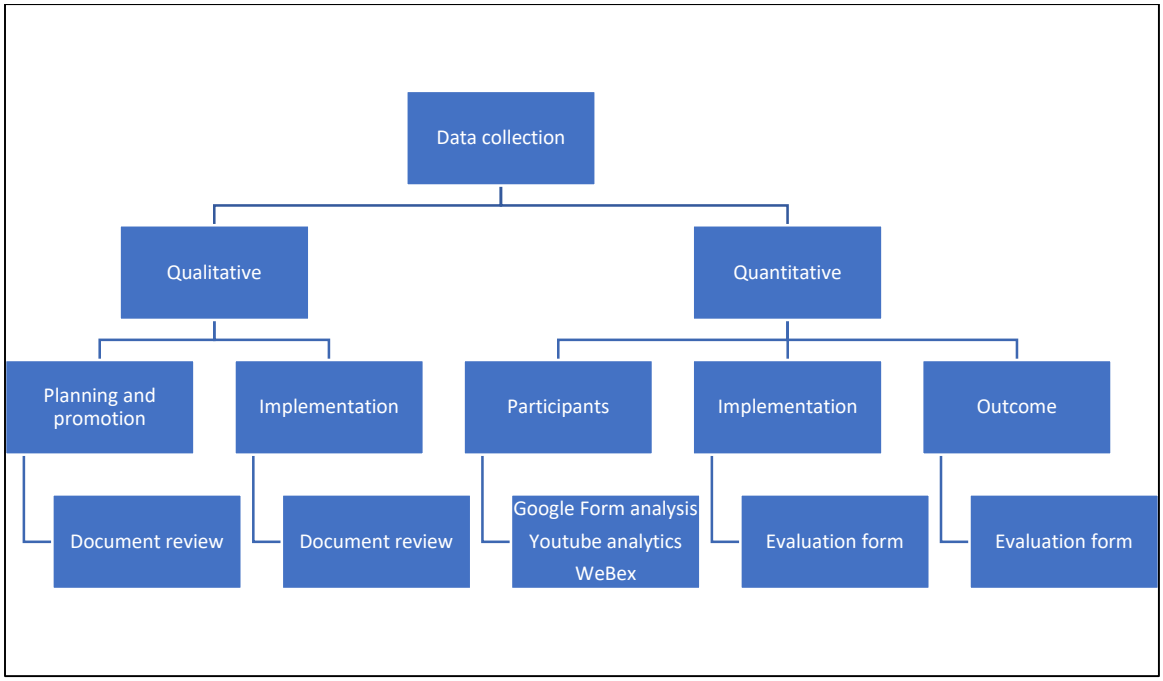
This paper aims to describe the evaluation of the implementation process and outcomes of this webinar. Examining the webinar activities and outcomes will help improve its effectiveness in the future. Apart from that, the evaluation of the outcome of this webinar will serve as a guide for the planning of intervention with regards to STEM Makerspace.

Method

This study adopted a mixed-method research design (Creswell, 2012), where qualitative and quantitative data are collected and analysed separately before merging to compare, merge or validate the results. The qualitative data were collected from the report, document review of the work process and online evaluation form. The work process is divided into (1) Planning and Promotion; (2) Participants; and (3) Implementation.

The documents reviewed were meeting minutes, discussion notes, e-mails, online registration forms, YouTube analytics report, Webex attendance and letters. Apart from that, the outcome of the webinar was evaluated through the analysis of the online evaluation forms which comprised participants' perceptions, experience, and interest on STEM Makerspace. The responses from evaluation forms were analysed quantitatively using descriptive statistics as well as qualitative interpretation of the given comments. Figure 2 summarises the data collection methods in this study.

Figure 2 Summary of the data collection



Planning and Promotion

A team was organised to plan and implement the webinar. The planning involved a series of meetings and discussions on the topics and suggestions from the panellists were conducted one month before the webinar. Invitation letters were sent through e-mails three weeks before the event. Phone calls and follow-up e-mails were sent out to obtain confirmation from the panellist. Upon receiving confirmation from all the panelists, a web banner was designed by the publication team. Five days before the event, a half-hour video communication was arranged between the moderator and the panelists for content coordination and update on the event details. Besides, the event coordinator initiated two dry-runs of the webinar involving the master of ceremony, moderator, technical and ICT team to ensure the smooth running of the event on the designated day. The panelists were invited to participate in the second dry-run to test their presentation and get familiar with the online platform.

Promotional strategies were carried out one week before the event. Strategies included dissemination through the SEAMEO Secretariat webpage promotion through the official SEAMEO RECSAM Facebook page, sending electronic mail (e-mail) to relevant contacts from the existing database, and the personal effort from the team members. One day before the event, another similar promotion was carried out, which acted as reminders.

Participants

Participation in the webinar was open to the public. People interested in participating in the webinar were required to register using an online form. The link and QR code were given in the web banner and the disseminated e-mails. A standardised reminder e-mail was sent to all

registrants one day before the webinar. One of the reasons for the registration was to monitor the number of webinar participants. This is because the Webex platform only allows 100 participants to access it. The webinar was conducted through Webex and was streamed live through the RECSAM YouTube channel. The registered participants were given the Webex access link, while those who did not manage to register can follow the webinar through YouTube.

Implementation

The actual webinar programme began with a short welcome note followed by an Opening address from RECSAM Center Director. This was then followed by the presentations of the three resource speakers. The core content topic presentations by the three panelists were supported by PowerPoint slides and videos, followed by a question-and-answer session. Each panelist was allocated 30 minutes of presentation followed by 5 minutes question and answer session. After all the presentations, there was an open 15-minute question and answer session whereby participants could pose their questions to any panelists. Participants via Webex were allowed to ask directly by turning on the microphone or pose in the chat box, while those in the live YouTube channel also posed their questions in the chat section, which the organising team member monitored. Table 1 presents the outline of the flow of the programme in the webinar.

Table 1 Outline of the Flow of the Webinar's Programme

Time	Programme
1:30 – 2:15	Admission of participants
2:15 – 2:30	Welcome note by MC
	Opening address from SEAMEO RECSAM Center Director
	MC
2:30 – 3:05	Moderator: Introduction of speaker and topic
	Presentation 1: STEM Education in Southeast Asia
	Q & A
3:05 –3:40	Moderator: Introduction of speaker and topic
	Presentation 2: STEM Makerspace in School
	Q & A
3:40 – 4:15	Moderator: Introduction of speaker and topic
	Presentation 3: STEM Makerspace in the Community
	Q & A
4:15 – 4:30	Open Q & A and Summary
	Group photo and Closing

Evaluation Form

An online evaluation form was designed for the participants to accomplish immediately at the end of the webinar. The link for the evaluation form was posted on the chatbox on Webex and YouTube. Upon completing the online Google Form, an e-certificate of participation was issued to the participants. The form consisted of demographic particulars of the participants, webinar delivery, perception of STEM Makerspace, and participants' experience and interest. The webinar delivery section was designed in a 5-point Likert scale in which 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree. The Likert scale measures attitudes using five points

(anchors) where the third point in the middle represents neutrality. For the Likert scale to be an interval scale, the distances between consecutive points on the scale are assumed to be the same (Chyung et al., 2017). In this study, the Likert scale is used as an interval scale to obtain the mean score of the items. The 11 items on webinar delivery and 13 items on participants' general perceptions and need on STEM Makerspace were formulated for the specific purpose of the webinar. Data analysis was performed in Microsoft Excel. Descriptive statistics were used to analyse the 5-point Likert scale data while quantitative data were transcribed into meaningful codes.

Results

Participation and Engagement

The Webex showed that 100 persons had registered through the online form before the webinar, including the three panelists and four working committee members, which were just right for the maximum capacity of the platform. However, only 57 (57%) registrants, including the panelists and the working committee members, accessed the Webex link during the webinar. An average of 21 live views of the webinar on YouTube was recorded, as shown in Figure 3.

Figure 3 Average of live views of the webinar

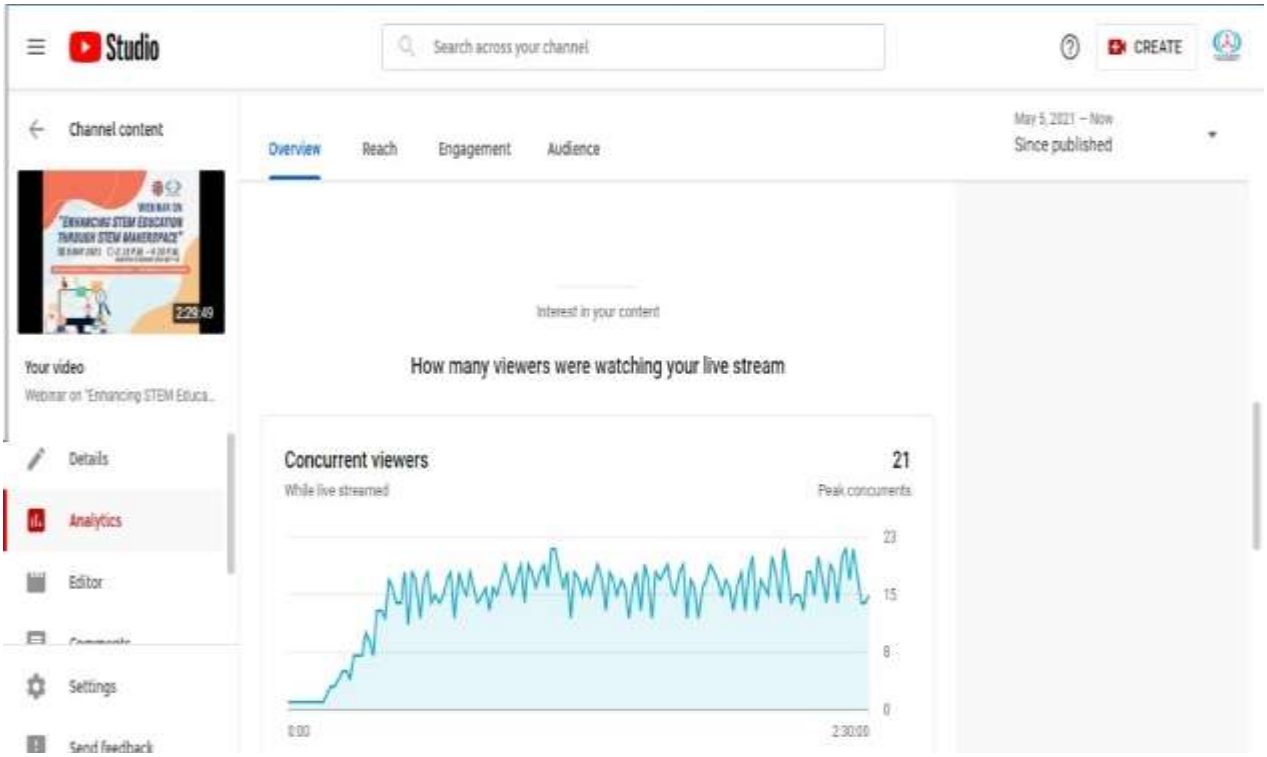


Table 2 summarises the registration and the number of people who accessed the webinar through Webex and RECSAM YouTube channel.

Table 2 Summary of the Participants who Accessed the Webinar through Webex and YouTube

Number of registrants	Number of participants in Webex	Number of live views on YouTube
100	57 (including three panelists and four working committee members)	21 (including one working committee member)

Webinar Implementation

Forty-one online evaluation forms were retrieved from webinar participants, equating to a 57.7 % response rate (excluding the panelists and working committee members). The average overall mean score for the category of webinar delivery was 4.53, with the highest mean score of 4.63 for items *'The panelists responded to queries appropriately'* and '*Staff at SEAMEO RECSAM assisted me well in joining the webinar'* respectively. Item '*Time allocation for each area of discussion was sufficient'* received the lowest mean score of 4.29. Table 3 presents the mean score for each item in the category of webinar delivery.

Table 3 Mean Score for the Items on Delivery in the Evaluation Form

Item	Mean (*N*=41)
I was well informed about the objectives of this webinar.	4.54
The pace of this webinar was appropriate.	4.51
Time allocation for each area of discussion was sufficient.	4.29
The panelists covered all aspects of the assigned topics.	4.54
The panelists responded to queries appropriately.	4.63
The webinar was moderated efficiently.	4.54
Staff at SEAMEO RECSAM assisted me well in joining the webinar.	4.63
The audio-video systems were clear.	4.54
This webinar was informative on the development of STEM education.	4.63
The content of this webinar is relevant to my teaching and learning.	4.61
I am eager to try out the ideas suggested in this webinar.	4.41
Average	4.53

Webinar Outcome

Perception of participants on STEM Makerspace. The participants' general perception of STEM Makerspace was evaluated and analysed in the subsequent sections of the evaluation form. The average mean score for the nine items about the perception of STEM Makerspace is 3.97 out of 5. The highest mean score is 4.59, in which participants perceive that *'STEM Makespace will help students in their academic achievement'*. Item *'I have the financial support in implementing STEM Makerspace in my context'* has the lowest score of 3.05. They also seem to agree that students will appreciate STEM education through a Makerspace approach. However, they seem to find it difficult to agree on having sufficient financial support, tools, and expertise to implement

STEM Makerspace relative to other items in this evaluation. Table 4 presents the mean score for each item on the participants' general perception of STEM Makerspace.

Table 4 Mean Score for Each Item on the Participants' General Perception of STEM Makerspace

Item	Score (out of 5)
I want to set up STEM Makerspace in my institution/community.	4.20
I have the expertise in implementing STEM Makerspace in my context.	3.76
I have sufficient tools in implementing STEM Makerspace in my context.	3.59
I have the financial support in implementing STEM Makerspace in my context.	3.05
Administrators in my institution will help implement a STEM Makerspace in my context.	4.17
Time allocation for STEM Makerspace will not be a problem in my institution.	3.98
My students in my institution will enjoy STEM education with a Makerspace approach.	4.46
The parents and community in my context will support STEM Makerspace activities.	3.95
STEM Makerspace will help students in their academic achievement.	4.59
Average	3.97

Experiences in STEM Makerspace. Twelve (29.3%) participants indicated that they had implemented STEM Makerspace in their institutions. However, only two participants gave a brief description of their implementation, as shown in Table 5.

Table 5 STEM Makerspace Implementation

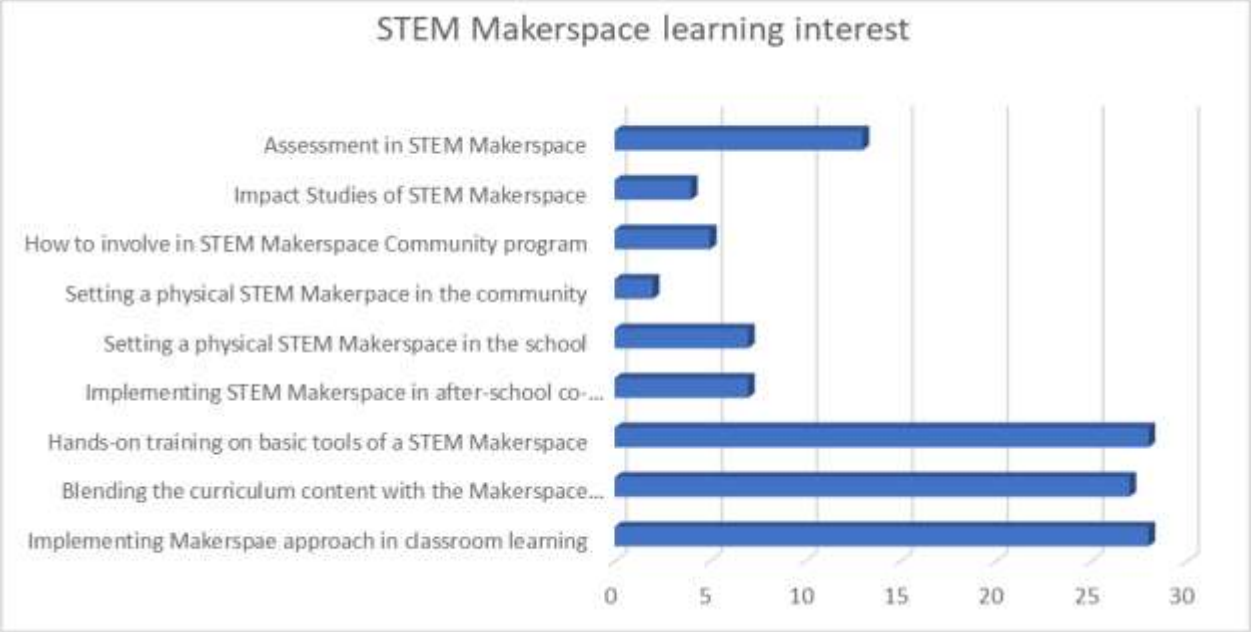
Have you implemented STEM Makerspace?	Yes – 12 (29.3%) No – 29 (60.7%)
If yes, please describe briefly.	- For Senior high school has done teaching and learning in the classroom. - At school

Aspects of interest in and needs for STEM Makerspace. Participants were also asked to choose three aspects of STEM Makerspace that they want to learn more about. Both item' *Implementing Makerspace approach in classroom learning'* and '*Hands-on training on basic tools of STEM Makerspace'* have the highest frequency of 28 (23.1%), respectively. This is followed closely by item *'Blending the curriculum content with Makerspace approach'* with a frequency of 27 (22.3%). The lowest frequency was on the item *'Setting a physical STEM Makerspace in the community'* with 2 (1.7%), followed by *'How to involve in STEM Makerspace Community Program'* with 5 (4.1%). Table 6 and Figure 4 present the aspects of STEM Makerspace that the participants want to learn more about.

Table 6 Aspects of Interest in STEM Makerspace

Item	Frequency
Implementing Makerspace approach in classroom learning	28
Blending the curriculum content with the Makerspace approach	27
Hands-on training on basic tools of STEM Makerspace	28
Implementing STEM Makerspace in after-school co-curricular activities	7
Setting a physical STEM Makerspace in the school	7
Setting a physical STEM Makerspace in the community	2
How to involve in the STEM Makerspace Community program	5
Impact Studies of STEM Makerspace	4
Assessment in STEM Makerspace	13
TOTAL responses	121

Figure 4 Graphic representation of the frequency of the aspects that the participants want to learn more about.



Comments on the Webinar. Apart from that, a few participants also wrote comments and appreciation regarding the webinar. Below are the verbatim comments taken from the evaluation form.

"Very informative and good sharing from all the panelists"

"Thank you very much for hosting such a comprehensive webinar. Thank you"

"Excellent"

"I've learned a lot from today's session. Looking forward to joining more webinars regarding STEM Education."

"Need more time for question-and-answer session."

"Looking forward to a face-to-face seminar."

"Other course more about hands-on STEM in school"

"Well organised & interesting webinar."

"It's informative."

Overall, the comments seem positive, constructive, and appreciative. One comment indicated that more time is needed for the question-and-answer session. This relates to the item '*Time allocation for each area of discussion was sufficient'* in the webinar delivery category, which scored 4.29 mean, the lowest among the other items.

Discussion

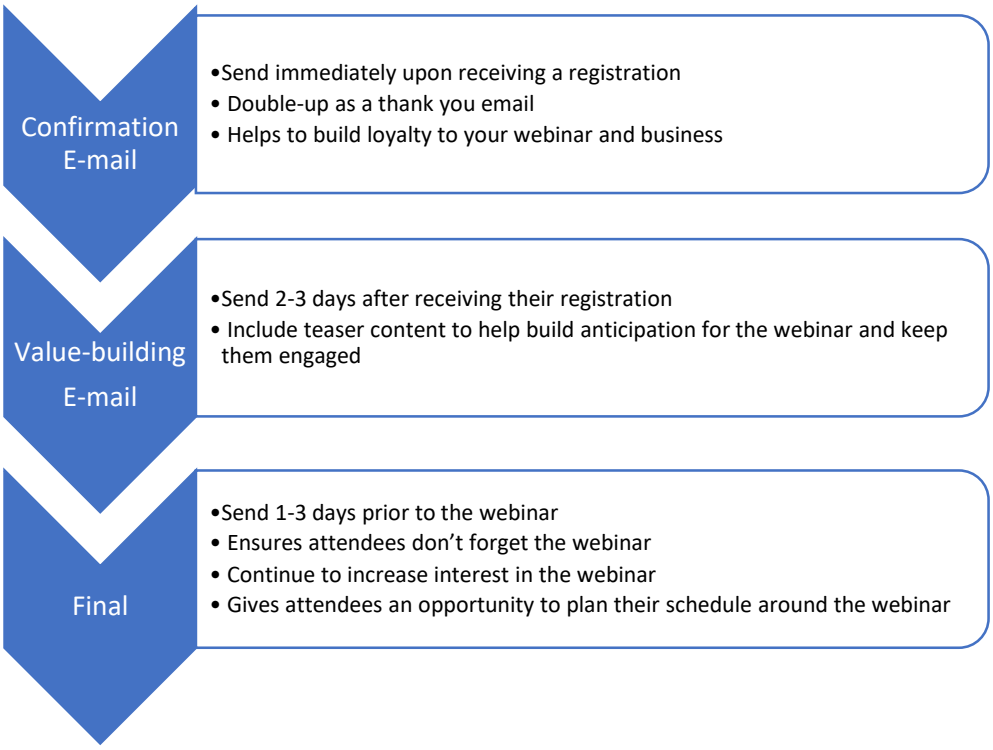
The discussion section focuses on evaluating the implementation process of the webinar, particularly the participation and delivery process, followed by the evaluation of the outcome. Recommendations and suggestions are given to improve further the planning and implementation of a similar webinar in the future.

Participation and delivery process

One of the objectives of using webinars is to overcome distance barriers in accessing information (Chiswell et al., 2018). The travel and group gathering restrictions during the Covid-19 pandemic have limited or put on hold many face-to-face professional development courses to be conducted physically. Thus, a webinar is one way to disseminate information and knowledge to participants who may be less likely to access similar resources. However, out of the 100 registered participants, only 57 (57%) participants accessed Webex.

There may be a few possible explanations for this. Firstly, it may be due to the short promotional period for the webinar. The dissemination of the webinar information was only carried out one week before the event. Perhaps many potential participants had other prior appointments or commitments. The recommended minimum period for promotion is at least two weeks (Hugel, 2019; Workcast, 2019). This would allow ample time for the promotion and announcement through various organisations such as the Ministry of Education, schools, colleges, and universities, besides e-mails to contacts in the database and social media network. Targeted promotion through educational institutions may reach out to more potential participants in which the webinar on STEM Makerspace is more relevant to them. Besides, it gives more time for the organiser to reinforce the promotion through a '3-Step E-mail Promotion' as recommended by Workcast (2019), as illustrated in Figure 5.

Figure 5 Three (3)-step e-mail promotion



Adapted from Workcast (2019, pg. 21)

Webinar outcomes

The main goal of the webinar is to create awareness of the role of STEM Makerspace in enhancing STEM education. Based on Table 4, they seem to positively perceive STEM makerspace. They also indicated positively about setting up STEM Makerspace in their context. Sufficient financial support, tools and expertise are three aspects that are difficult to agree upon compared to the other items. This relates to the areas that the participants want to learn in the future, implementing the Makerspace approach in classroom learning, blending the curriculum content with the Makerspace approach, and learning basic tools in Makerspace. These three items scored the highest compared to the other aspects participants wanted to learn more about.

The abovementioned Table 5 indicated that 60.7% of participants have not yet started makerspace in the school. Apart from that, Table 6 shows that most of the participants indicated that they want to learn more on how to implement makerspace approach and receive more hands-on training on the basic tools in makerspace. Specialised knowledge and training may be necessary for teachers to implement makerspace as an approach, as instructional support during makerspace activities are crucial to the cognitive and affective outcomes (Mersand, 2021). Oliver (2016a) recommended that professional development content for teachers interested in implementing makerspace should focus on the questions of 'what, why and how'. Teachers have to understand what is a makerspace, its definition, its variations, and its scope. The next crucial question is related to the intrinsic motivation on 'why should I bother with a makerspace', which relates to the significance of

implementing makerspace in the teaching and learning process. Lastly, professional development will emphasize how to run and teach using through makerspace, which help educators to develop a basic understanding of how makerspace can benefit their curriculum. The STEM Makerspace needs assessment will be discussed in future studies.

Recommendations

The analysis of the online evaluation revealed participants' perception of the webinar's delivery and their perception and needs regarding STEM Makerspace. Overall, participants perceived positively the implementation of the webinar. The average score for the items under this category is 4.53 out of 5. However, only 57 (57%) registrants, including the panelists and the working committee members, accessed the Webex link during the webinar. An average of 21 live views of the webinar on YouTube was recorded. This imply that more effort needs to be put in to encourage and engage more participants in the webinar. One recommendation is to disseminate the webinar information to potential participants at least two weeks before the event. With this preparation, it is hoped that the participants can make the necessary arrangements to join the webinar. The delivery of the webinar seems to be well perceived by the participants. However, more time for interactive discussion and question and answer can be allocated for the webinar sessions. The outcome of the webinar is evaluated through participants' feedback about STEM Makerspace.

The mean score for participants' general perception of STEM Makerspace is 3.97 out of 5, which implies that generally, they perceived quite positively about STEM Makerspace. Participants want to learn about three aspects of STEM Makerspace: implementing a makerspace approach in classroom learning, hands-on training on basic tools of STEM makerspace and blending the curriculum content with the Makerspace approach. The outcome evaluation indicated that the participants positively perceived STEM Makerspace. They are eager to learn more about Makerspace as an approach in their classroom teaching and learning. These findings serve as a basis for professional development for educators in their respective contexts. An important aspect to be considered in STEM Makerspace Professional Development, as Mersand (2021) and Oliver (2016a) mentioned is: STEM makerspace professional training must begin with answering the 'what, why and how' questions. In answering the 'how' question, the educators indicated the method of blending makerspace with the curriculum content and implement them in classroom learning. The training can also include hands-on training on how to handle some basic tools in makerspace activities. For future research, the evaluation of the outcome of the webinar can be formulated to capture and cover the content or topics by the invited speakers in the webinar. This can provide more meaningful data and in-depth analysis. For this study, only the outline of the content was provided to the organizer, and thus, in-depth questions were not formulated.

Conclusion

This study described the evaluation of the implementation process and outcomes of the webinar 'Enhancing STEM education through STEM Makespace'. The analysis of the online evaluation revealed participants' perception of the webinar's delivery and their perception and needs regarding STEM Makerspace. Overall, participants perceived positively the implementation of the webinar. The average score for the items under this category is 4.53 out of 5. The mean score

for participants' general perception of STEM Makerspace is 3.97 out of 5, which implies that generally, they perceived quite positively about STEM Makerspace. Participants want to learn about three aspects of STEM Makerspace: implementing a makerspace approach in classroom learning, hands-on training on basic tools of STEM makerspace and blending the curriculum content with the Makerspace approach. The results imply that participants are willing to learn more about STEM Makerspace. Future courses and training can be planned according to the aspects participants want to learn more. Thus, the findings of the outcome of the webinar help make judgments and guide the selection of interventions for the STEM Makerspace.

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