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Nurturing the Maker Mindset in Pre-Service Teachers: A Study of the Effect of a STEM Camps

Jatutip Kaya [1]and Suthida Chamrat [2*]
[1]*Doctor of Philosophy Program in Education (Science education), Faculty of Education, Chiang Mai university, Thailand*
[2]*Department of Curriculum, Instruction and Learning, Faculty of Education, Chiang Mai University, Thailand*
*Email: suthida.c@cmu.ac.th

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Abstract. This study investigates the effect of STEM camps on developing a maker mindset in pre-service science teachers. A total of 11 pre-service teachers participated in a 2-month fieldwork experience that included attending STEM camps three times and a debrief session. The Maker Mindset questionnaire was used to assess changes in the participants' maker mindset over the fieldwork experience. The STEM camp, based on a DIY tinker and maker framework, consisted of 13 activities that aimed to promote an understanding of STEM concepts and principles through experiential learning. The data indicated significant changes in several categories of the Maker Mindset questionnaire between the pre-STEM camp and post-STEM camp. Specifically, the level of "Change," "Learn," "Play," and "Make" increased, while the level of "Self-efficacy" decreased. These findings suggest that the STEM camp had a positive effect on the development of a maker mindset in pre-service science teachers. The findings also pointed that to promote the maker mindset in STEM camps effectively, it is important to address skills such as growth mindset, grit, and collaboration.

Keywords: Maker mindset, Pre-service teachers, STEM camp

INTRODUCTION

STEM (Science, Technology, Engineering, and Mathematics) education has been identified as an important area of study for a number of reasons. There is a large body of literature that supports the numerous benefits of STEM education. Some of the key benefits that have been identified include the development of critical thinking and problem-solving skills, promoting creativity and innovation, supporting economic growth and competitiveness, and enhancing career opportunities and earning potential. These benefits have been consistently reported in a wide range of research studies and reports. According to a report by the National Science Board (2018), STEM education can help students develop skills such as problem-solving, critical thinking, and collaboration, which are important for success in the 21st-century workforce (p. 4). In addition, STEM education has encouraged creativity and innovation, as students are asked to think critically and creatively while developing solutions to real-world problems (Barrow & Stepien, 2019, p.

3). The U.S. Department of Commerce (2019) also highlights the importance of STEM education for economic growth and competitiveness, stating that "a strong STEM workforce is critical to America's economic growth and competitiveness in the global marketplace" (p. 1). Finally, research has shown that STEM occupations have grown at a faster rate and have higher median earnings than non-STEM occupations (National Science Board, 2018, p. 4).

Maker education, which emphasizes hands-on, experiential learning and problem-solving, can be a powerful complement to STEM education (Smith & Grady, 2016). Maker activities can provide students with opportunities to apply their STEM knowledge and skills in authentic and meaningful contexts, while also promoting creativity and innovation (Kapur, 2019). By engaging in maker activities, students can learn to think critically and creatively, and to develop the confidence and persistence needed to solve complex problems (Barrow & Stepien, 2019).

Maker education can also support the development of a growth mindset, which is the belief that one's abilities can be developed through effort and learning (Dweck, 2006). By participating in maker activities, students can learn to embrace challenges and failures as opportunities for growth, and to persevere in the face of obstacles (Kapur, 2019). This can help to foster a sense of resilience and determination that can be valuable in both personal and professional endeavors (Smith & Grady, 2016).

Integrating maker education into STEM instruction can lead to mutually reinforcing outcomes, as both approaches can support the development of critical skills and attitudes that are important for success in the 21st century (Kapur, 2019). Maker education, which emphasizes hands-on, experiential learning and problem-solving, can provide students with opportunities to apply their STEM knowledge and skills in authentic and meaningful contexts, while also promoting creativity and innovation (Barrow & Stepien, 2019). By integrating maker education into STEM instruction, educators can create engaging and meaningful learning experiences that support the growth and development of students as makers and thinkers (Kapur, 2019).

Pre-service teachers in science may benefit from having a maker mindset for several reasons. Having a maker mindset can help pre-service teachers to develop a deeper understanding and appreciation of the scientific process (National Science Board, 2018). Maker activities, which typically involve designing, building, and testing prototypes or solutions to real-world problems, can provide pre-service teachers with the opportunity to engage in hands-on, experiential learning that mirrors the iterative and inquiry-based nature of scientific research (Honey & Kanter, 2013). By participating in maker activities, pre-service teachers can gain a better understanding of the process of scientific inquiry, including how to ask and answer questions, gather and analyze data, and communicate findings (National Science Board, 2018).

A maker mindset can help pre-service teachers to develop their problem-solving skills and creativity (Dweck, 2006). Maker activities often require students to think critically and creatively and to develop solutions to complex problems (Honey & Kanter, 2013). Participating in maker activities allows pre-service teachers to approach challenges with flexibility, persistence, and resourcefulness, which can be valuable skills in the classroom (National Science Board, 2018). A maker mindset can help pre-service teachers engage and motivate their students (Dweck, 2006). Maker activities can be highly engaging and motivating for students, as they allow learners to take an active role in shaping their learning experiences and to see the tangible results of their efforts (Honey & Kanter, 2013). By incorporating maker activities into their teaching, pre-service teachers can help to foster a sense of ownership and agency among their students, which can in turn, enhance motivation and engagement (National Science Board, 2018).In general, developing a maker mindset can be an essential part of the professional development of pre-service

teachers in science, as it can help them to become more effective and innovative educators who are able to engage and motivate their students (Dweck, 2006).

Research has shown the importance of studying the impact of STEM camps on pre-service teachers' development of a maker mindset. Maker education, which emphasizes hands-on, experiential learning and problem-solving, can complement STEM education by providing opportunities for students to apply their STEM knowledge in authentic contexts while promoting creativity and innovation. In addition, maker education can support the development of a growth mindset, encouraging students to embrace challenges and failures as opportunities for learning and growth. These skills and attitudes are critical for success in the 21st century.

Martinez and Stager (2013) argue that maker education is a stance towards learning that emphasizes agency, complexity, and perseverance. Halverson and Sheridan (2014) found that maker education can promote a growth mindset by encouraging students to embrace failure as an opportunity for learning and improvement. Bleicher and Lindgren (2020) conducted a study that examined the impact of a STEM summer camp on pre-service teachers' maker mindset, finding that the camp increased their confidence in teaching STEM subjects and willingness to incorporate maker activities in their teaching. The study also found that the camp helped to foster a growth mindset among the pre-service teachers. Similarly, Weaver and colleagues (2021) investigated the effect of a week-long maker camp on high school students' self-efficacy and attitudes towards STEM, finding a significant increase in their self-efficacy in STEM and interest in pursuing STEM careers. These studies provide evidence that STEM and maker camps can have a positive impact on the development of essential skills and attitudes among pre-service teachers and students. This can help to foster a sense of resilience and determination that can be valuable in both personal and professional endeavors. In summary, STEM and maker education can be mutually reinforcing, as each approach can support the development of essential skills and attitudes critical for success in the 21st century. By studying the effect of STEM camps on the development of a maker mindset in pre-service teachers, researchers can better understand the potential benefits of maker education and how it can be effectively integrated into STEM instruction.

RESEARCH OBJECTIVES

The research objective of a study examining the effect of STEM camps on developing a maker mindset in pre-service teachers.

METHODOLOGY

The research study described in the provided information focused on the effect of STEM camps on the development of a maker mindset in pre-service teachers in science. In this study, 11 pre-service teachers participated in a fieldwork experience that included two months of intensive STEM camp preparation, followed by attendance at STEM camps three times and a debrief session. The main research instrument used in this study was the maker mindset questionnaire developed by the first author as a part of the doctoral thesis. The research study was conducted in the year 2021, in February, and the pre-service teachers participated in the fieldwork experience during this time. The study aimed to examine the effect of the STEM camps on the development of a maker mindset in pre-service teachers. The maker mindset questionnaire was used to gather data from the participants and assess changes in their mindset over the fieldwork experience.

Participants

This study investigates the effect of STEM camps on developing a maker mindset in pre-service science teachers enrolled in a science education program in the Faculty of Education. The research study included 11 student participants who had majors in chemistry and biology and were recruited through a combination of purposive sampling and voluntary sampling from the fourth year of their program. Of the 11 participants, 9 were female and 2 were male. The participants volunteered to participate in the study and completed a 2-month fieldwork experience that included attending STEM camps three times and a debrief session. The research followed The Belmont Principles, which are three basic principles that are particularly relevant to the ethics of research involving human subjects: the principles of respect of persons, beneficence, and justice.

Research Tools

STEM Camp

The STEM camp is a special educational program organized by the school and faculty of education that aims to promote an understanding of science, technology, engineering, and math (STEM) concepts and principles through hands-on and mind-on activities. This STEM camp was based on a DIY (do-it-yourself) tinker and maker framework, which encourages students to engage in experiential learning through the use of everyday materials and specific equipment such as robots and microcontrollers. The camp consisted of 13 activities spanning various STEM disciplines, including life science, physical science, earth science, and computing science, and was conducted over a period of 18 hours at a school on Wednesdays in February 2021. A total of 300 students participated in the camp, with pre-service teachers serving as trainers to support their learning. The STEM camp provided an opportunity for pre-service teachers to develop their pedagogical skills and foster a maker mindset, as they engaged in collaborative learning, design thinking, and problem-solving activities with the students.

The maker mindset questionnaire

The Maker Mindset questionnaire, also known as the Behavior Scale, is used to measure the conceptual level of a Maker. It consists of 42 items that are divided into two parts: general information about the informant and items that measure the informant's level of feeling or behavior towards certain Maker concepts. These concepts are grouped into six categories: Change, Learn, Self-efficacy, Play, Make Participate, and Share. Pre-service individuals are asked to answer the questionnaire and indicate their level of agreement or disagreement with each statement, providing insight into their conceptual level as a Maker. The development of the research instrument involved a try-out process and expert review. The try-out process involved administering the instrument to a small group of participants to identify any potential issues or confusing items. Feedback was collected from these participants to refine the instrument. The final version was then reviewed by three experts in the field to ensure its validity and relevance. These experts provided feedback on the clarity and appropriateness of each item, as well as suggestions for any necessary revisions. The final version of the research instrument was deemed valid and appropriate for use in the study.

In the Maker Mindset questionnaire, informants are asked to rate their feelings or behaviors on a scale from *1* to *5*, with *5* indicating the highest level of agreement and *1* indicating the lowest level of agreement. By rating their feelings and behaviors on this scale, informants can provide a more nuanced and detailed understanding of their mindset and approach toward making. The categories and items included in the Maker Mindset questionnaire were documented from a range of sources, including Hatch (2013), Dougherty (2013), Chamrat (2018), Myers (2017), Pierrat (2016), Martin and Dixon (2014), Klepper et al. (2017), Pacock (2016), Gerstein (2016), Chu et al. (2015), and

Martin (2015). These sources have contributed to the development the framework of maker mindset showed in Figure 1.

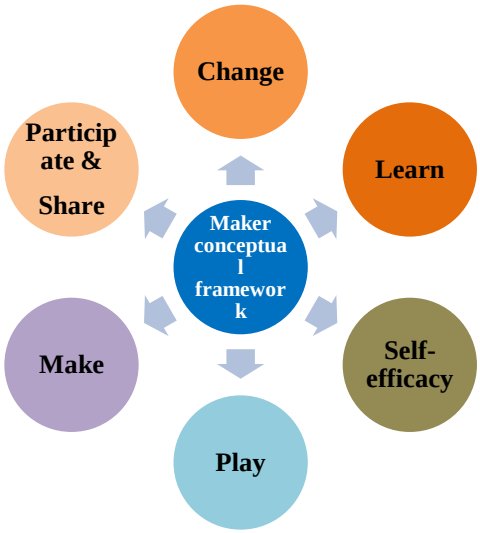

Figure 1: the conceptual framework of the maker mindset

The research methodology used in the study can be represented in the research process diagram shown in Figure *2*

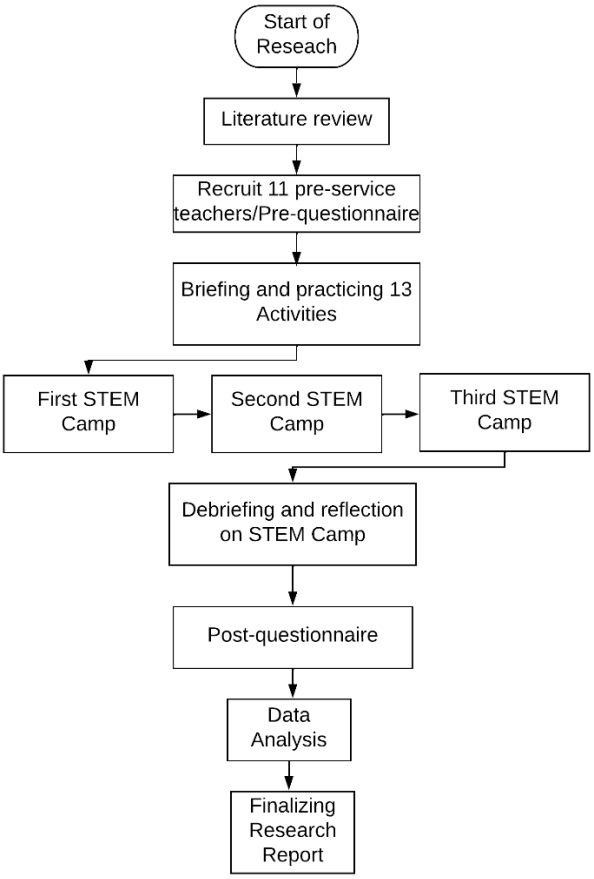

Figure 2: research process diagram

Data Collection

The data for this research study was collected both before and after pre-service teachers participated in a fieldwork experience that included 2 months of intensive STEM camp preparation, followed by attendance at STEM camps 3 times, and a debrief session.

Data Analysis

This research study used descriptive statistics to analyze the data's frequency and average. The data were analyzed in both pre-service teachers' maker mindset and the level of maker mindset in each indicator and sub-indicator. The data was analyzed by counting the frequency of each indicator and sub-indicator for each pre-service teacher. The analysis was conducted for the six categories of indicators, which were Change, Learn, Self-efficacy, Play, Make Participate, and Share, both at an individual level and an overall level.

RESULTS AND DISCUSSION

Table 1 shows each participant's average scores for the maker mindset questionnaire, both before and after participating in the STEM camp.

Table 1: Pre-service teachers' maker mindset before and after participating in STEM camp

Pre-service Teacher	AVERAGE of Pre-STEM Camp Maker Mindset	AVERAGE of Post-STEM Camp Maker Mindset
1	3.93	4.43
2	3.81	4.26
3	4.17	5.00
4	3.97	3.71
5	4.22	3.90
6	3.79	4.48
7	4.24	4.26
8	4.00	4.79
9	3.95	3.47
10	3.93	3.95
11	5.00	4.57

The table shows the average pre-STEM camp maker mindset scores and average post-STEM camp maker mindset scores of 11 pre-service teachers. The pre-STEM camp scores range from 3.79 to 4.24, with an overall average of 4.02. The post-STEM camp scores range from 3.47 to 5.00, with an overall average of 4.29. The data indicates that the majority of the participants had an increase in their maker mindset scores after attending the STEM camp, with the highest increase being from participant 3 (pre-camp score: 4.17, post-camp score: 5.00). It was found that the STEM camp positively affected the maker mindset of most participants, as their average scores increased after attending the camp. However, some participants saw a decrease in their average scores after attending the camp. A comparison of the maker mindset of pre-service teachers is shown in Figure 3.

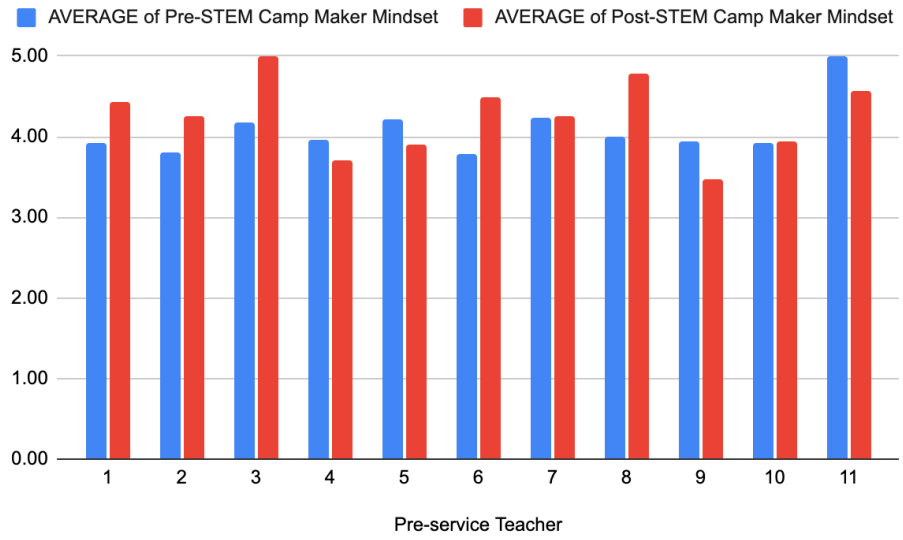

FIGURE 3: Pre-service teachers' maker mindset before and after participating in STEM camp

Tables 2 through 7 present the average maker mindset of pre-service teachers, with each maker mindset indicator consisting of 7 sub-indicators. The sentences for each sub-indicator are also provided.

Table 2: Pre-service teachers' maker mindset in each indicator 1 Change and Sub-Indicators before and after participating in STEM camp

Indicator/ Sub-indicator	Maker Mindset Indicators	Pre-STEM Camp	Post-STEM Camp
Indicator	1. Acceptance of changes that may occur (Change)	4.23	4.45
Sub-indicator 1.1	Acceptance of change: I am open to and accepting of changes that occur naturally, and am able to adapt to new situations and embrace change	4.18	4.55
Sub-indicator 1.2	Courage and risk-taking: I am courageous and confident in my decisions, and am not afraid to take calculated risks in order to achieve my goals.	4.09	4.36
Sub-indicator 1.3	Accepting mistakes: I accept my mistakes. without feeling ashamed When the mistake is caused by one's own decision or action	4.45	4.64
Sub-indicator 1.4	Positive attitude towards failure: Every time there is a failure. I always look at failure positively.	4.27	4.45
Sub-indicator 1.5	Open-mindedness: I am open to learning new things and am willing to consider new ideas and perspectives	3.91	4.09
Sub-indicator 1.6	Technology literacy: I like to be open minded to learning. and always accepting new technological changes	4.27	4.45
Sub-indicator 1.7	Seeking expert knowledge: I actively seek out information and guidance from experts and trusted sources, and value learning from others	4.45	4.64

Table 3: Pre-service teachers' maker mindset in each indicator 2 Learn and Sub-Indicators before and after participating in STEM camp

Indicator/ Sub-indicator	Maker Mindset Indicators	Pre-STEM Camp	Post-STEM Camp
Indicator	2. Learning how to learn (Learn)	4.03	4.21
Sub-indicator 2.1	Determination and persistence: I am determined and persistent in achieving my goals, and am able to maintain focus and patience in the face of challenges and obstacles.	4.18	4.55
Sub-indicator 2.2	Interest in learning: "I have a strong desire to learn and am always seeking out new opportunities to expand my knowledge and skills."	4.00	4.36
Sub-indicator 2.3	Belief in learning: “I am confident in my ability to learn and believe in the value of learning new things."	4.30	4.45
Sub-indicator 2.4	Interest in learning unique topics: "I am drawn to unusual or unconventional topics and ideas and enjoy learning about things that are different or unusual."	3.82	3.73
Sub-indicator 2.5	Learning from problems: "I am interested in learning from the problems and challenges around me and use them as opportunities to grow and improve."	4.09	4.09
Sub-indicator 2.6	Tool literacy: "I am interested in learning about and using different tools, and am willing to explore new technologies and resources in order to create the desired workpieces."	3.64	4.18
Sub-indicator 2.7	Seeking feedback: "I value receiving feedback on my work and seek out opportunities to receive guidance from experts and other trusted sources."	4.18	4.09

Table 4: Pre-service teachers' maker mindset in each indicator 3 Self-efficacy and Sub-Indicators before and after participating in STEM camp

Indicator/ Sub-indicator	Maker Mindset Indicators	Pre-STEM Camp	Post-STEM Camp
Indicator	3.Perception of self-efficacy (Self-efficacy)	4.23	4.19
Sub-indicator 3.1	Interest in learning: “I am motivated to learn and pursue topics that interest me."	4.18	4.36
Sub-indicator 3.2	Problem-solving: “I am able to find and create solutions to challenges and obstacles on my own."	4.36	4.00
Sub-indicator 3.3	Reflective practice: “I engage in regular self-reflection in order to improve my performance and better understand my own capabilities and limitations."	4.18	4.27
Sub-indicator 3.4	Self-evaluation: “I regularly evaluate my own work and processes in order to identify areas for improvement."	4.09	4.18

Table 4: (Cont')

Indicator/ Sub-indicator	Maker Mindset Indicators	Pre-STEM Camp	Post-STEM Camp
Sub-indicator 3.5	Seeking feedback: "I value receiving feedback on my work and seek out opportunities to receive guidance from experts and other trusted sources."	4.27	4.09
Sub-indicator 3.6	Autonomy in learning: "I value the freedom to pursue my own interests and learning goals, and am able to manage my own learning activities effectively."	4.27	4.09
Sub-indicator 3.7	Believe in self-learning in special and unique topics: "I have unique interests and enjoy exploring and urge for learning about unconventional or unusual topics."	4.27	4.36

Table 5: Pre-service teachers' maker mindset in each indicator 3 Play and Sub-Indicators before and after participating in STEM camp

Indicator/ Sub-indicator	Maker Mindset Indicators	Pre-STEM Camp	Post-STEM Camp
Indicator	4.Love to play with Exploration and experimentation (Play)	4.05	4.44
Sub-indicator 4.1	Playful approach to learning: "I enjoy experimenting and exploring new ideas and approaches in my learning."	4.18	4.45
Sub-indicator 4.2	Interest in learning: "I am always interested and engaged in my learning, and enjoy the process of learning new things."	4.09	4.36
Sub-indicator 4.3	Sense of surprise and discovery: "I am often surprised by what I learn and enjoy discovering new things."	3.91	4.45
Sub-indicator 4.4	Excitement about learning: "I am excited about learning and always look forward to new opportunities to learn and grow."	4.18	4.36
Sub-indicator 4.5	Pride in learning: "I am proud of what I learn and the progress I make in my learning."	4.18	4.55
Sub-indicator 4.6	Curiosity: "I am curious and enjoy exploring and learning about things that are new or unfamiliar to me."	4.00	4.45
Sub-indicator 4.7	Asking questions: "I enjoy asking questions and seek out opportunities to learn more about the things that interest me."	3.82	4.45

Table 6: Pre-service teachers' maker mindset in each indicator 4 Make and Sub-Indicators before and after participating in STEM camp

Indicator/ Sub-indicator	Maker Mindset Indicators	Pre-STEM Camp	Post-STEM Camp
Indicator	Making and creating (Make)	3.82	4.24
Sub-indicator 5.1	Enjoyment of making and doing: “I enjoy the process of making and creating, and find it to be a fun and rewarding experience."	4.00	4.36
Sub-indicator 5.2	Innovation: “I am interested in developing new ideas and approaches, and enjoy creating challenging and unique pieces."	3.91	4.09
Sub-indicator 5.3	Tinkering: “I enjoy modifying or improving things in an informal or unique way, and have a love of tinkering."	3.91	4.18
Sub-indicator 5.4	Repetition and experimentation: “I am willing to repeat experiments and try different approaches in order to bring my ideas to fruition."	3.73	4.36
Sub-indicator 5.5	Persistence: “I am persistent and determined in achieving my goals, and am able to maintain focus and patience in the face of challenges and obstacles."	3.91	4.40
Sub-indicator 5.6	Seeking feedback: “I value receiving feedback on my work and seek out opportunities to receive guidance from experts and other trusted sources."	3.70	4.20
Sub-indicator 5.7	Interest in making something unique: “I have unique interests and enjoy exploring and making about something unconventional or unusual topics."	3.60	4.10

Table 7: Pre-service teachers' maker mindset in each indicator Participation and sharing and Sub-Indicators before and after participating in STEM camp

Indicator/ Sub-indicator	Maker Mindset Indicators	Pre-STEM Camp	Post-STEM Camp
Indicator	Participation and sharing	4.19	4.09
Sub-indicator 6.1	Interest in creative design: “I am interested in the field of creative design and enjoy learning about the work of creators from around the world."	4.00	4.00
Sub-indicator 6.2	Connecting with others: “I enjoy connecting with others who share my interests and finding ways to collaborate and learn from one another."	3.60	4.00
Sub-indicator 6.3	Collaboration in maker spaces: “I believe in the value of collaboration and see maker spaces as an opportunity to exchange ideas, learn from one another, and share resources and knowledge."	4.10	4.00
Sub-indicator 6.4	Sharing experiences and knowledge: “I enjoy working with others to share new experiences and knowledge, and believe that collaboration is an important part of learning and growth."	4.30	4.20

Table 7: (Cont')

Indicator/ Sub-indicator	Maker Mindset Indicators	Pre-STEM Camp	Post-STEM Camp
Sub-indicator 6.5	Collaboration for new knowledge: "I believe that collaboration is an important way to generate new knowledge and ideas."	4.50	4.10
Sub-indicator 6.6	Sharing with others: "I enjoy sharing what I know and do with others and find joy in sharing my interests and passions."	4.30	4.20
Sub-indicator 6.7	Responsibility for the future: "I believe it is important to contribute to the development of our world and I am committed to being a part of building a better future for all."	4.50	4.10

The data set from Table 2-7 presented in Figure 4, which show more visual of maker mindset level in 6 indicators and 42 sub-indicators. The average data of six indicators are also shown.

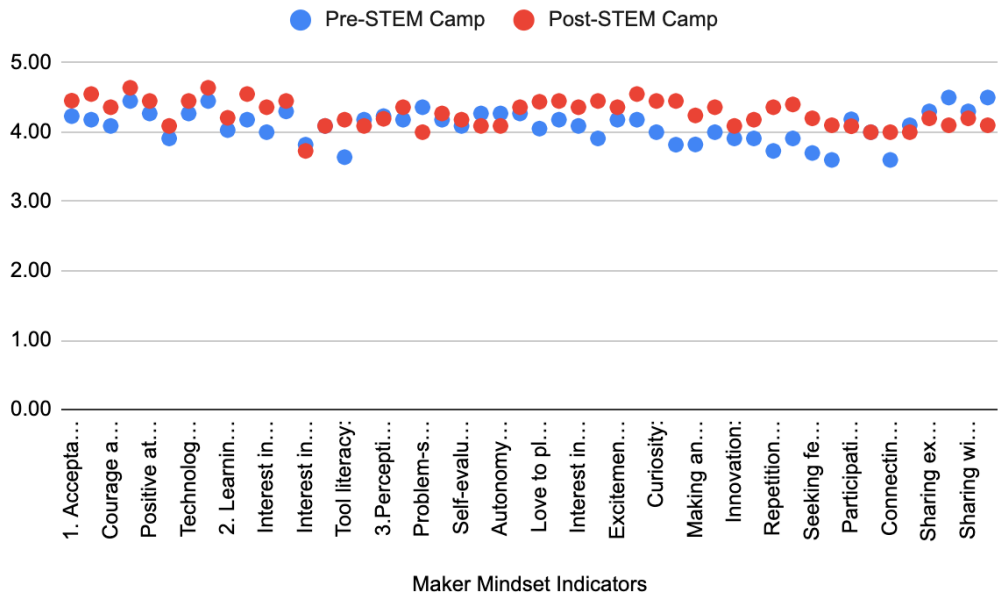

Figure 4: Comparisons of pre-service teachers' maker mindset in each indicator and sub-indicator before and after STEM camp participation

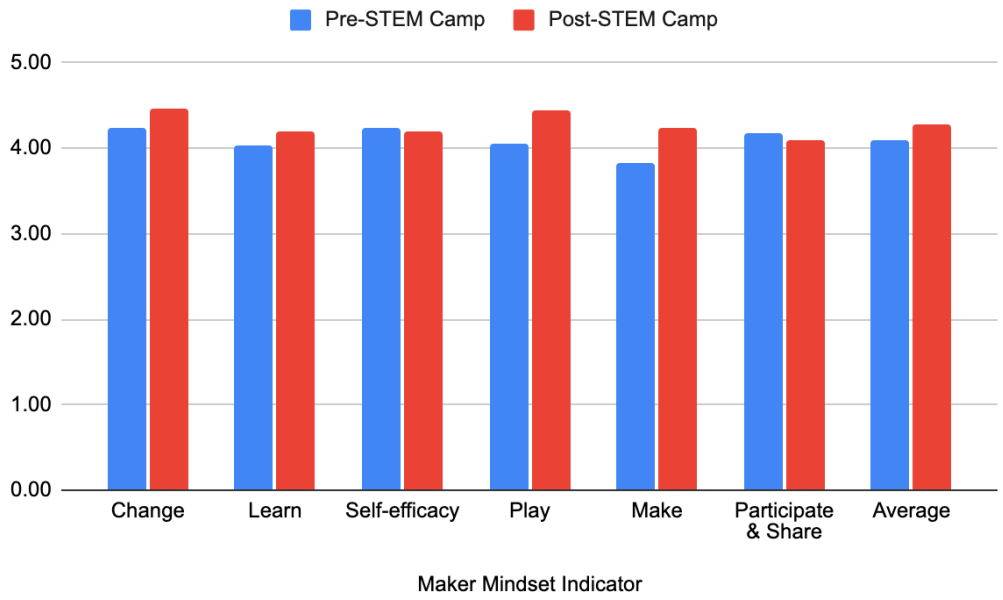

Figure: 5 Comparisons of pre-service teachers' maker mindset in each indicator before and after STEM camp participation

Comparing the pre-service maker mindset between pre-STEM-camp and post-STEM in six indicators and 42 sub-indicators reveals that the pre-service teachers' mindset increased overall. However, However, there are some indicators and sub-indicators that decreased. Comparing the scores between pre- and post-STEM camp, the data shown in Table 8.

Table 8: Comparisons of change in pre-service teachers' maker mindset in each indicator

Maker Mindset Indicator	Pre-STEM Camp	S.D.	Post-STEM Camp	S.D.	Increase/decrease
Change	4.23	0.19	4.45	0.19	0.22
Learn	4.03	0.23	4.21	0.28	0.18
Self-efficacy	4.23	0.09	4.19	0.14	-0.04
Play	4.05	4.05	4.44	0.06	0.39
Make	3.82	0.15	4.24	0.13	0.42
Participate & Share	4.19	0.32	4.09	0.09	-0.10
Average	**4.09**	**0.24**	**4.27**	**0.20**	0.18

The table above presents the average scores for each maker mindset indicator in the pre-STEM-camp and post-STEM conditions. Overall, there was an increase in the average maker mindset scores from the pre-STEM camp to the post-STEM condition. The most significant increase was observed in the "Play" indicator, which significantly increased from 4.05 to 4.44. The "Make" indicator also saw a notable increase, from 3.82 to 4.24. On the other hand, the "Change" and "Learn" indicators saw relatively small increases, from 4.23 to 4.45 and from 4.03 to 4.21, respectively. The "Participate & Share" indicator

saw a slight decrease, from 4.19 to 4.09, while the "Self-efficacy" indicator remained relatively stable, with a minor decrease from 4.23 to 4.19.

These results suggest that the STEM camp positively affected the maker mindset of most participants, as most of the indicators saw an increase in scores from the pre-STEM camp to the post-STEM condition. However, because the data of Self-efficacy and Participate & Share indicators show the decline of pre-service teachers' maker mindset, the data in table 8 are present to see the details of the change in each sub-indicator.

Table 9: The Comparisons change in Pre-service teachers' maker mindset in each indicator and Sub-Indicators before and after participating in STEM camp

Maker Mindset Indicators	Pre-STEM Camp	Post-STEM Camp	increase or decrease
1. Acceptance of changes that may occur (Change)	**4.23**	**4.45**	0.22
Acceptance of change:	4.18	4.55	0.37
Courage and risk-taking:	4.09	4.36	0.27
Accepting mistakes:	4.45	4.64	0.19
Positive attitude towards failure:	4.27	4.45	0.18
Open-mindedness:	3.91	4.09	0.18
Technology literacy:	4.27	4.45	0.18
Seeking expert knowledge:	4.45	4.64	0.19
2. Learning how to learn (Learn)	**4.03**	**4.21**	0.18
Determination and persistence:	4.18	4.55	0.37
Interest in learning:	4.00	4.36	0.36
Belief in learning:	4.30	4.45	0.15
Interest in unique topic:	3.82	3.73	-0.09
Learning from problems:	4.09	4.09	0.00
Tool literacy:	3.64	4.18	0.54
Seeking feedback:	4.18	4.09	-0.09
3.Perception of self-efficacy (Self-efficacy)	**4.23**	**4.19**	-0.04
Interest in learning:	4.18	4.36	0.18
Problem-solving:	4.36	4.00	-0.36
Reflective practice:	4.18	4.27	0.09
Self-evaluation:	4.09	4.18	0.09
Seeking feedback:	4.27	4.09	-0.18
Autonomy in learning:	4.27	4.09	-0.18
Believe in self-learning in special and unique topics:	4.27	4.36	0.09

Table 9: (Cont')

Maker Mindset Indicators	Pre-STEM Camp	Post-STEM Camp	increase or decrease
Love to play with Exploration and experimentation (Play)	**4.05**	**4.44**	0.39
Playful approach to learning:	4.18	4.45	0.27
Interest in learning:	4.09	4.36	0.27
Sense of surprise and discovery:	3.91	4.45	0.54
Excitement about learning:	4.18	4.36	0.18
Pride in learning:	4.18	4.55	0.37
Curiosity:	4.00	4.45	0.45
Asking questions:	3.82	4.45	0.63
Making and creating (Make)	**3.82**	**4.24**	0.42
Enjoyment of making and doing:	4.00	4.36	0.36
Innovation:	3.91	4.09	0.18
Tinkering:	3.91	4.18	0.27
Repetition and experimentation:	3.73	4.36	0.63
Persistence:	3.91	4.40	0.49
Seeking feedback:	3.70	4.20	0.50
Interest in making something unique:	3.60	4.10	0.50
Participation and sharing	**4.19**	**4.09**	-0.10
Interest in creative design:	4.00	4.00	0.00
Connecting with others:	3.60	4.00	0.40
Collaboration in maker spaces:	4.10	4.00	-0.10
Sharing experiences and knowledge:	4.30	4.20	-0.10
Collaboration for new knowledge:	4.50	4.10	-0.40
Sharing with others:	4.30	4.20	-0.10
Responsibility for the future:	4.50	4.10	-0.40

Table 9 showed the average scores for the Learning how to learn (Learn) Maker Mindset Indicator and its seven sub-indicators for the pre-STEM camp and post-STEM camp. The sub-indicators include Determination and persistence, Interest in learning, Belief in learning, Interest in unique topics, learning from problems, Tool literacy, and Seeking feedback.

One interesting finding from the data is that the sub-indicator for Interest in learning in the Learn indicator showed a significant increase in average scores, with a change of 0.36 from pre-STEM camp to post-STEM camp. This suggests that the STEM camp experience had a positive effect on the participants' motivation to learn and their overall interest in learning new things. Additionally, the sub-indicator for Determination and persistence in

the same indicator also showed a notable increase, with a change of 0.37. This highlights the potential for the STEM camp to foster key skills such as determination and persistence, which are important for success in any field. These findings indicate that the STEM camp experience positively affected the participants' attitudes toward learning and their ability to persevere in the face of challenges.

In the "Making and Creating" indicator, there was an overall increase in the average maker mindset scores from the pre-STEM camp to the post-STEM camp, with a 0.42-point increase. While most sub-indicators saw an increase, there was a decrease in the "Interest in Unique Topic" sub-indicator, with a decrease of 0.09 points. The highest increase was seen in the "Repetition and Experimentation" sub-indicator, with a 0.63-point increase. The lowest increase was seen in the "Innovation" sub-indicator, with a 0.18-point increase.

According to the results, STEM camps can be an effective way to develop the maker mindset in young people, particularly in the aspects of "Make", "Play", "Change", and "Learn" (Kabir & Brewer, 2017). One study found that STEM camps that emphasized hands-on, project-based learning and provided access to various tools and materials helped foster a maker mindset in participants. This learning environment allows campers to "Make" by actively creating and building projects and encourages them to "Play" and experiment with different materials and techniques. Another study by Buechley and Peppler (2014) found that maker-centered learning environments can help young people develop a "Change" mindset by providing opportunities for learners to take ownership of their own learning and make decisions about the direction of their projects. This type of learning can help pre-service teachers to develop a sense of agency and empowerment, as well as a willingness to embrace change and take risks.

Focusing on "Participation and sharing" and "Perception of self-efficacy", it is important to consider that the development of life skills such as participation and sharing, as well as perception of self-efficacy, can be influenced by various factors and may take time to develop. For example, a study by Chen and colleagues (2018) found that participation in extracurricular activities, such as STEM camps, can positively affect the development of self-efficacy in pre-service teachers. However, this process may be influenced by a range of factors, including the type and quality of the activities being engaged in, the individual characteristics of the participants, and the social and cultural context in which the activities take place.

The findings from Dweck's (2006) study demonstrate the importance of mindset in shaping individuals' self-efficacy and their willingness to take on new challenges. However, developing a growth mindset is not an overnight process and requires consistent effort over time. In this regard, programs such as STEM camps can play a critical role in helping pre-service teachers develop life skills such as participation and sharing, which can contribute to the development of a growth mindset (Kilinc et al., 2017). As noted by Duckworth and colleagues (2007), grit is another important factor that contributes to success in various contexts. Research has shown that grit can be developed through deliberate practice and effort, which aligns with the idea of growth mindset. Therefore, it is essential to recognize that the development of these skills is a continuous process and requires ongoing support and encouragement from educators (Duckworth, 2016). Ultimately, incorporating opportunities for experiential learning and growth mindset development in teacher education programs may not only benefit pre-service teachers but also enhance their ability to effectively teach STEM subjects to their future students (Turan et al., 2020).

CONCLUSION AND IMPLICATIONS

STEM camps can be effective in promoting the maker mindset in pre-service teachers, particularly in the areas of "Make", "Play", "Change", and "Learn". These camps can foster determination and persistence, interest in learning, and tool literacy, among other skills, through hands-on, project-based learning and access to various tools and materials. Maker-centered learning environments can also help pre-service teachers develop a "Change" mindset, as they take ownership of their learning and make decisions about the direction of their projects. However, the development of life skills such as participation and sharing and perception of self-efficacy may be influenced by various factors and may take time to develop. Programs such as STEM camps that provide opportunities for experiential learning and encourage a growth mindset may be particularly effective in helping pre-service teachers develop these skills.

To promote the Maker mindset in STEM camps, it is important to address further life skills such as growth mindset, grit, and collaboration. By fostering these skills, STEM camps can provide pre-service teachers with the tools and support they need to embrace new challenges, persevere in the face of setbacks, and work effectively with others. This can help to create a more engaging and meaningful learning experience and ultimately help pre-service teachers to develop the Maker mindset.

In this study, it is essential to note that these conclusions are based on a small sample of pre-service teachers and may need to be more generalizable to the larger population. Further research is needed to understand STEM camps' effect on maker mindsets' development.

LIMITATION OF THE STUDY

While the study provides valuable insights into the impact of STEM camps on the development of a maker mindset in pre-service teachers, there are some limitations to consider. One of the primary limitations is the small sample size. With only 11 participants, the study may not be representative of the larger population of pre-service teachers. This can limit the generalizability of the findings and suggest caution in applying them to a broader context. To address this limitation, it may be helpful to conduct larger-scale studies with a more diverse range of participants. Additionally, qualitative methods, such as interviews or focus groups, could supplement the quantitative results by providing a deeper understanding of the pre-service teachers' experiences with the STEM camp and their perceptions of its impact on their maker mindset development. Furthermore, it is important to note that the study only examined the short-term impact of the STEM camp on the pre-service teachers' maker mindset. It would be beneficial to conduct follow-up studies to investigate the long-term impact of the camp on their teaching practices and student outcomes.

In summary, while the study provides valuable insights into the impact of STEM camps on the development of a maker mindset in pre-service teachers, the small sample size and short-term focus of the study are limitations to consider. The use of qualitative methods and larger-scale studies can help address these limitations and provide a more comprehensive understanding of the impact of STEM camps on pre-service teachers' development.

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