THE IMPACT OF SCIENCE FAIR ON THE STUDENTS' ENGAGEMENT, CAPACITY, CONTINUITY, AND MOTIVATION TOWARDS SCIENCE LEARNING

[1*]Kiah-Ju Ong, [2]Ying-Chyi Chou, [1]Ding-Yah Yang
[1]Department of Chemistry, College of Science, Tunghai University, Taiwan.
[2]Department of Business Administration, College of Management, Tunghai University, Taiwan.
*email: ongkiahju@gmail.com

DOI: https://doi.org/10.37134/jpsmm.vol9.1.1.2019

Abstract

KLESF: The Fair 2017 is 3-day science fair organized in Malaysia to promote STEM education. This event has been conducted for four consecutive years, yet, little is known about the impact of the event. This study investigated the impact of KLESF: The Fair on Malaysia high school students. 360 students from three secondary schools volunteered to participate in the survey. They completed a pre-test on students' motivation toward science learning before the event. A post-test, identical to the pre-test plus student engagement, capacity, and continuity outcome questionnaire was administered after the event. Results indicated that the students were engaged to and gained new knowledge from the event. This event positively influenced their desire to pursue a science-related career. The students' motivation towards science learning has improved significantly after the event. Many students commented that the event was interesting, fun, attractive, enjoyable; they can learn and remember the science knowledge easily.

Keywords *KLESF: The Fair 2017, science fair, engagement, capacity, science-related career, motivation towards science learning*

INTRODUCTION

KLESF is an acronym of Kuala Lumpur Engineering Science Fair. It is a programme initiated in 2013 by the ASEAN Academy of Engineering and Technology (AAET), Universiti Tunku Abdul Rahman (UTAR), Malaysian Industry-Government Group for High Technology (MIGHT), The Institution of Engineers Malaysia (IEM), and National Science Centre; with the aim to promote the interest in science, technology, engineering, and mathematics (STEM) among the school students in Malaysia (Lee, Hong, & Mohd, 2014). Through KLESF, programmes such as KLESF Mentor Development Programme, KLESF Mentorship Programme, KLESF Mobile Workshop, KLESF Mini Workshop are being organized from time to time being to promote STEM education among the school students in Malaysia. KLESF: The Fair is an annual science fair organized by KLESF to promote STEM education in Malaysia.

The world is evolving towards Industrial 4.0 since the starts of the twenty-first-century. Industrial 4.0 has transformed the industries and society (Lee et al., 2018) as artificial intelligence, robotics, technologies, automation, and Internet of Things (IoT) are present at everywhere. STEM skills are in demand in future workplaces (Deloitte Access Economics, 2014). It is estimated that 75 million of future jobs will be replaced by artificial intelligence, robotics, and technologies (World Economic Forum, 2018). To adapt and survive in this challenging world, it is indispensable to well-equipped the young generation with twenty-first-century skills (Kivunja, 2015), scientific literacy (Glynn, Brickman, Armstrong, & Taasoobshirazi, 2011), and STEM skills (Deloitte Access Economics, 2014).

STEM is an acronym of science, technology, engineering, and mathematics. STEM education means the teaching of the STEM disciplines: science, technology, engineering, and mathematics; likewise, an integrated approach of teaching that increase students' interest and knowledge in STEM-related fields (Rosicka, 2016).

STEM education develops professionalism and capability in each individual STEM field and the ability to work across fields (The Scottish Government, 2017). Besides providing STEM-related knowledge, STEM education also prepares one with STEM skills like analytical, logical thinking, quantitative analysis, creativity, open-mindedness, objectiveness, critical thinking, and independence (Office of the Chief Scientist, 2016).

STEM education is always a priority in Malaysia's education system. In 1970, Malaysia Education system started to implement the 60:40 Science: Arts policy (Academy of Science Malaysia, 2018). This policy advocates for 60% of students into Science/Technical stream while the other 40% into Art streams. The policy has been implemented for almost half a decade, yet, there is still a huge gap to reach the targeted ratio. According to the ministry of education Malaysia statistical reports, the enrolment of STEM stream students has been declining from 48.15% in 2012 to 45.74% in 2017(Academy of Science Malaysia, 2018).

Since the twenty-first-century skills, scientific literacy, and STEM skills are vital for the development of a country, therefore, a lot of effort has been contributed in promoting STEM education. The Ministry of Education Malaysia has worked out several strategies through the Malaysia Education Blueprint (2013-2025) to promote STEM education in Malaysia (Ministry of Education Malaysia, 2013). The science curriculum was revised; science project competitions such as National Science Challenge (NSC) and National Robotics Competition (NRC) are being organized regularly to promote STEM education in Malaysia (Suhanna, Lilia, & Zanaton, 2015).

Science fairs have been organized for decades to promote science learning among the students.
Research has indicated that science fairs have an impact on the students who participated in the science fairs' project competition (Gomez, 2007; Sahin, 2013; Schmidt, 2014; Schmidt & Kelter, 2017; Sumrall & Schillinger, 2004; Valerie, 2013; Yasar & Baker, 2003), however, the studies about the impact of science fairs on the students (non-participants of science project) is scarce. Built on the earlier literature, the present study extended the previous research by investigating the impact of science fair on the secondary school students (non-participant in science project competition).

KLESF: The Fair 2017 is an annual 3-day science fair organized by KLESF. KLESF: The Fair 2017 gathered the relevant STEM content providers to provide science-related activities for the students and the public (Lee et al., 2014). KLESF: The Fair 2017 is slightly differing from other science fairs as it is free admission and open to the public. The activities conducted during the event are science experiment demonstration, hands-on experiments, science workshops, international science projects competition, science magic show, STEM exhibition by NGO, government and universities and etc. There were 416 schools, 50 STEM-related industry corporations, 24 universities, 14 non-government organizations, and 9 government organizations, participated in the event. Throughout the 3-day, KLESF: The Fair 2017 was visited by 61,000 people. The visitors were from Malaysia, Indonesia, China, Hong Kong, Myanmar, Cambodia, and Thailand. Although KLESF: The fair 2017 received active participation from the public, yet, the efficacy of KLESF: The fair 2017 on the high school students in Malaysia is not scientifically evaluated. Hence, it is significant to investigate the impact of KLESF: The Fair 2017 on the students' motivation toward science learning and the students' perception towards the event.

LITERATURE REVIEW

STEM Education

SMET education was introduced by the National Science Foundation (NSF) in the early 1990s (Chute, 2009). SMET is the acronym of Science, Mathematics, Engineering, and Technology. In 2001, Dr. Ramaley reorganized the term SMET into STEM when she was the assistant director of the education and human resources at NSF (Chute, 2009). There is no single definition or comprehensive definition for STEM. The definition of STEM can be slightly subjective as it is shaped by the central objectives which hold by a country, agency or stakeholder (Academy of Science Malaysia, 2018). Although there is no fixed definition, universally, STEM is known as disciplines of knowledge consisting of Science (Physics, Chemistry, and Biology), Technology, Engineering. and Mathematics.

The concept of STEM education is also significantly different based on the level of education (Breiner, Harkness, Johnson, & Koehler, 2012). The definition is getting more precise and concrete when the curriculum becomes more specialized at the advanced levels of education (Xie, Fang, & Shauman, 2015). Generally, STEM education means the teaching of the STEM disciplines: Science (physics, chemistry, biology, earth, and environmental science), Technology, Engineering, and Mathematics. STEM education is an integrated approach of teaching that increase students' interest and knowledge in STEM-related fields (Rosicka, 2016). STEM education develops one's professionalism in each individual STEM field and the capability to work across fields (The Scottish Government, 2017). Moreover, it also develops one's capability to construct new knowledge or ideas through interdisciplinary learning (The Scottish Government, 2017). Eventually, STEM education prepares one with STEM-related knowledge, twenty-first-century skills, and STEM skills.

Science Fair

Science fairs have been organized for many decades to promote science learning among the students, however, most of the science fairs are focusing on the science projects competition and students' participation in the science fair. The research about science fairs were mainly focused on the judge's perspective on the science fairs (Peter & Ron, 2011), teacher and preservice teacher opinions/ experience about science fairs (Fisanick, 2010; McCarthy, 2015; Tortop, 2013; Tortop, 2014), the factors that influence students' participation in science fair (Dionne et al., 2011; Korkmaz, 2012; Ndlovu, 2014; Sonnert, Sadler, & Michaels, 2013), high school science fair and research integrity (Grinnell, Dalley, Shepherd, & Reisch, 2017), the impact on student science inquiry learning and attitudes toward STEM (Schmidt & Kelter, 2017), effects of science fair competitions on students (Gomez, 2007; Sahin, 2013; Schmidt, 2014; Sumrall & Schillinger, 2004; Valerie, 2013; Yasar & Baker, 2003), and how to maximize the benefits of students science projects and science fairs to students and minimize the burden to teachers (Wartinger, 1999).

KLESF: The Fair 2017

KLESF: The Fair 2017 is an annual 3-day science fair organized by KLESF. The members of KLESF are ASEAN Academy of Engineering and Technology (AAET), Universiti Tunku Abdul Rahman (UTAR), Malaysian Industry-Government Group for High Technology (MIGHT), and The Institution of Engineers Malaysia (IEM) (KLESF, n.d.). The KLESF Fait is supported by the Ministry of Education (MOE) Malaysia, Ministry of Energy, Science, Technology, Environment and Climate Change (MESTECC), Malaysian Communications and Multimedia Commission (MCMC), Academy of Sciences Malaysia (ASM), Associated Chinese Chambers of Commerce and Industry Malaysia (ACCCIM) and Malaysian Institute of Physics (IFM) (KLESF, n.d.). The objectives of KLESF Fair are: to enhance the students' interest in science, technology, engineering and mathematics (STEM), to create public awareness on the roles and importance of STEM, to enhance the awareness and participation of the industries in the promotion of STEM education and provide a platform and networking for schools, educators, and industries to explore and share their information and experience on STEM projects and practices in the STEM field (Lee et al., 2014). The activities provided during the KLESF Fair were science experiment demo, hands-on experiment, science workshop, science project competition, science magic show, STEM exhibition by NGO, government and universities (Lee et al., 2014). KLESF Fair is open to the public; with free admission.

The first KLESF Fair, KLESF: The Fair 2014 happened on 25-27 April 2014 at the National Science Centre of Malaysia (Lee et al., 2014). KLESF: The Fair 2014 was visited by 19,690 people. The number of visitors was then increased to 27,647 (in 2015) and 54,267 (in 2016). Furthermore, the number of schools, companies, NGOs, universities, government agencies that participated in the KLESF Fair was increasing as well from year to year. In 2015, students from the Philippines, Cambodia, and Thailand started to participate in KLESF; The Fair 2015 ("KLESF: The Fair 2015," 2015, 10-11). The students from Myanmar started to participate in KLESF: The Fair 2016 ("KLESF: The Fair 2016," 2016, 10-11). KLESF Fair is receiving active participation from the public, yet, the efficacy of KLESF Fair 2017 is yet to scientifically evaluated. Hence, it is significant to understand the impact of KLESF: The Fair on high school students in Malaysia.

Science Learning

According to the assumption of self-determination theory, the desire to learn is innate; still, it can be influenced by social factors (Ryan & Deci, 2000). Learning could be influenced by the factors such as cognitive, affect, attitude, interest, and learning approach (Alsop et al. 2005). According to the constructivism learning theories, the students should be an active player during the learning process; they need to identify their present understandings/knowledge, interpreting the meaning of current experiences, make proper adjustment to their knowledge framework; consequently, they construct their own knowledge (Boghossian, 2006). The students are constructing knowledge when they are having active and dynamic interaction with the physical and social environment (Vygotsky, 1978). In science learning, active learning and social interaction help to internalize new or complex understandings, problems, and processes (Glasson, 1993).

Typically, the classroom is the place for the students to learn about scientific inventions, discoveries, and theories. However, the scientific concepts taught in the classroom are often abstract and detach from the real world. According to the situated learning theory, the students can only learn effectively when the knowledge is conveyed in an authentic context; and social interaction and collaboration are indispensable during the learning process (Lave & Wenger, 1991). Research has indicated that when the students' science learning motivation was enhanced when they were learning in an authentic context (Hung, Hwang, & Huang, 2012; Tseng, Tuan, & Chin, 2009). The study conducted by Los and Schweinle (2019) has shown that instructional environment has an influence on the students' motivation and academic outcome. Besides, Cicuto and Torres (2016) reported that active learning environment has a positive influence on the student's motivation in learning Biochemistry. Research also indicated that learning science in leisure setting (Falk & Storksdieck, 2005; Falk & Storksdieck, 2009) and hands-on activities (Said & Cakiroglu, 2011) can enhance the students' science learning motivation.

Motivation towards Science Learning

Motivation drives a person to act, commit and accomplish his goals; it determines one's focus and attainment (Noe et al., 1997). Motivation is a continuum of amotivation, extrinsic motivation, and intrinsic motivation (Ryan & Deci, 2000). Challenging tasks, curiosity, interest, and joy are the factors that can trigger intrinsic motivation; an intrinsically motivated person engages in an activity automatically and naturally (Ryan & Deci, 2000). There are four types of extrinsic motivation: external regulation, introjected regulation, identified regulation, and integrated regulation (Ryan & Deci, 2000). Extrinsic motivation could be stimulated by external factors such as rewards, money, grades, threat, please someone or escape from punishment (Gagne & Deci, 2005).

Motivation has significant positive influences on science learning (Liu, Horton, Olmanson, & Toprac, 2011; Milner, Templin, & Czerniak, 2011). Students science knowledge scores increased significantly when their motivation scores increased (Liu et al., 2011). Research done by Areepattamannil and Kaur (2012) showed that motivation in science is a significant predictor of science achievement. When Sun, Bradley, and Akers (2012) conducted a study on the 2006 PISA Hong Kong sample, the findings showed that students with higher motivation and higher self-efficacy showed better science academic achievement.

Motivation is playing an important role in science learning. However, nowadays, many science majors and non-science majors lack or lose the motivation to learn science (Glynn, Brickman, Armstrong, & Taasoobshirazi, 2011). Hence, it is important to trigger the students' motivation in science learning.

The Present Study

To investigate the impact of the KLESF: The Fair 2017, the research aimed to answer the following research questions:

1. To what extent do the students' engagement, capacity, and continuity exist in the KLESF: The Fair 2017?
2. Does KLESF: The Fair 2017 influence the students' motivation toward science learning?
3. What are the students' perceptions toward KLESF: The Fair 2017?

METHODOLOGY

A mixed method comprising of quantitative and qualitative research methods was employed in this study. A pre and post-test design was used to identify the impact of the KLESF: The Fair 2017 on the students' engagement, capacity, continuity, motivation towards science learning, and the students' perception toward KLESF: The Fair 2017. The students completed pre-test on "Students' motivation toward science learning questionnaire (SMTSL)" before attended to the KLESF: The Fair 2017. A post-test on "Students' motivation toward science learning questionnaire (SMTSL)", "Student engagement, capacity, and continuity (ECC) outcome questionnaire (ECC trilogy)", and an open-ended question was administered a week after the event.

Participants

A total of 360 students (aged 13 - 17) from 3 different independent high schools in Malaysia volunteered to participate in this activity. Of these, 168 (46.67%) valid surveys were retrieved, there were 106 females (63.10%) and 62 males (36.90%).

Research Instrumentation

Student engagement, capacity, and continuity (ECC) outcome questionnaire (ECC trilogy)

In STEM education, engagement, capacity, and continuity are the standards used to evaluates the success of a program; these concepts are known as ECC trilogy (John, Bettye, Ezra, & Robert, 2016). Engagement means creating the awareness, interest, and motivation in STEM; capacity means acquired the knowledge and skills needed in the STEM field; continuity refers to support systems such as the material resources, extracurricular activities, and the guidance in the STEM field (Jolly, Campbell, & Perlman, 2004). The student engagement (3-item), capacity(2-item), and continuity (5-item) (ECC) outcome questionnaire was adopted from John et al. (2016). The students need to indicate their level of agreement on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

Students' motivation toward science learning questionnaire (SMTSL)

The students' motivation toward science learning (SMTSL) questionnaire was adopted from Tuan, Chin, and Shieh (2005). There are six scales in the questionnaire: self-efficacy (7-item), active learning strategies (8-item), science learning value (5-item), performance goal (4-item), achievement goal (5-item), and learning environment stimulation (6-item). Students need to indicate their level of agreement on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The Cronbach alpha coefficient was found to be 0.87.

Open-ended questions

1. How do you feel about KLESF: The Fair 2017?

Data analysis

The data collected were analysed with SPSS 16.0 application. The t-test test was performed. Quotes from the students were arranged and tabulated.

RESULTS

Student Engagement, Capacity, and Continuity (ECC) Outcome (ECC trilogy)

Table 1 shows student opinions on the ECC trilogy. Of the three questions on the subscale concerning engagement in KLESF: The Fair 2017, "I like KLESF: The Fair 2017" was the highest-rated statement, with the mean score 3.867 (0.842). This lowest-rated statement concerning engagement was "My behaviour has improved because of the KLESF: The Fair 2017", with the mean score of 3.281 (0.828). For the statement concerning capacity, the highest-rated statement was "I have gained new knowledge and facts because of the KLESF: The Fair 2017", with the mean score of 3.922 (0.711). Whilst, for the statement concerning continuity, the statement "KLESF: The Fair 2017 provided an opportunity for me to evaluate existing belief systems as they impact career choice?" received the highest mean score of 3.343 (0.744). The lowest-rated statement was "I would like to become a scientist after attended the activities in the KLESF: The Fair 2017", with the mean score of 2.737 (0.920).

Table 1 *Descriptive Statistics for Students' Opinions on ECC Trilogy*

		Mean	Std Dev
Engagement			
1.	I like KLESF: The Fair 2017.	3.867	0.842
2.	The KLESF: The Fair 2017activities are most interesting to me.	3.744	0.742
3.	My behaviour has improved because of the KLESF: The Fair 2017.	3.281	0.828
Capacity			
4.	I have gained new knowledge and facts because of the KLESF: The Fair 2017.	3.922	0.711
5.	I have obtained useful information from KLESF: The Fair 2017 that can apply in choice of career.	3.539	0.774
Continuity			
6.	KLESF: The Fair 2017 will make me want to pursue a STEM career.	3.072	0.788
7.	I would like to become a scientist after attended the activities in the KLESF: The Fair 2017.	2.737	0.920
8.	My values and/or attitudes been impacted as a result of the KLESF science fair.	3.229	0.711
9.	My fellow students have changed thoughts about their career choices.	3.036	0.695
10.	KLESF: The Fair 2017 provided an opportunity for me to evaluate existing belief systems as they impact career choice?	3.343	0.744

Students' Motivation toward Science Learning (SMTSL)

Table 2 illustrates the SMTSL scores and standard deviation for pre-test, post-test, and the t-test analysis of the students. A significant difference was noted between the pre-test and post-test of SMTSL scores ($t = 11.666$, $p \leq 0.001$). The findings show that KLESF: The Fair 2017 significantly enhanced the students' motivation toward science learning. A significant difference was noted as well for the self-efficacy subscale, ($t = 5.048$, $p \leq 0.001$). The pre-test scores for active learning strategies was 29.071 and the post-test scores was 30.107, a significant difference was noted ($t = 4.489$, $p \leq 0.001$). Significant differences were noted as well for science learning value ($t = 4.236$, $p \leq 0.001$), performance goal ($t = 3.319$, $p \leq 0.001$), achievement goal ($t = 5.190$, $p \leq 0.001$), and learning environment stimulation ($t = 7.419$, $p \leq 0.001$).

Table 2 *Pre and Post-test SMTSL Scores, Standard Deviation, and t-test Analysis*

Scales	No. of students	Pre-test		Post-test		t	p
		Score	Std Dev	Score	Std Dev		Sig. (2-tailed)
Self-efficacy	168	23.738	3.731	24.839	3.723	5.048	.000**
Active learning strategies	168	29.071	4.663	30.107	3.967	4.489	.000**
Science learning value	168	17.875	3.061	18.642	2.842	4.236	.000**
Performance goal	168	13.494	2.701	14.155	2.766	3.319	.001**
Achievement goal	168	17.161	3.202	18.179	2.854	5.190	.000**
Learning environment stimulation	168	18.446	3.448	20.208	2.820	7.419	.000**
Overall SMTSL	168	119.786	13.731	126.131	12.355	11.666	.000**

Note. **$p \leq 0.001$

Students' Perceptions toward KLESF: The Fair 2017

All the students gave positive feedback about the KLESF: The Fair 2017. The comments given by the students were summarized and listed in Table 3.

Table 3 *Students' Perceptions toward KLESF: The Fair 2017*

Comments
Interesting, fun, enjoyable, attractive, not boring, special.
KLESF: The Fair provided many opportunities to learn by doing/experiencing.
I had a better understanding of the scientific knowledge.
I can learn science easily.
I had more exposure to science.
I had a deeper impression on the scientific knowledge.
I can do the experiments on my own, this gave me a lot of self-satisfaction.
KLESF: The Fair provided many opportunities to learn a lot of scientific facts.
I think DIY is the best way to explain a science theory.
There were many creative projects and demonstrations.
I can learn step by step.
I can learn more and remember it more clearly if I did it myself and not just reading it.
The experiments/ workshops developed my problem-solving skills.
I learned a lot of new technologies.
The experiments showed were more practical and related to our daily life.
The demonstrators were very friendly and explained the answers very well and detail.
I have an interest in science and have many questions to ask. The demonstration of experiments. there had answered part of my questions.

DISCUSSION

This study provides strong support for the impact of the KLESF: The Fair 2017 on the students' motivation toward science learning. To date, research about the impact of the science fair on the students' (non-participants in science project competition) motivation toward science learning is hardly found, as most of the research were focusing on the participants of projects competition, perception of teachers and factors that influencing the participation of science projects. However, literature has indicated that the activities that conducted during the

KLESF: The Fair 2017 such as science experiments demonstration (Freedman, 2000; Palmer, 2007), science workshops (Rukavina, Zuvic-Butorac, Ledic, Milotic, & Jurdana-Sepic, 2012), hands-on experiments (Dhanapal & Evelyn Wan, 2014; Kuo, Liu, & Leou, 2012; Said & Cakiroglu, 2011), science projects competition (Burguillo, 2010), science magic show (Lin et al., 2014), science exhibition (Vainikainen, Salmi, &Thuneberg, 2015) have positive influences on the students.

Based on the constructivism learning theories, the students construct their knowledge through student-centred learning activities (Boghossian, 2006). The science workshops and hands-on activities that conducted during KLESF: The Fair 2017 were active learning activities/ strategies. During the activities, the students were the active participants; they discovered the new knowledge through the interaction with the environment, interpreted the knowledge and constructed their knowledge (Boghossian, 2006). According to the literature, content knowledge has an influence on the learning motivation (Williams & Williams,2011) and self-efficacy (Swackhamer, Koellner, Basile, & Kimbrough, 2009). Self-efficacy refers to one's judgment on their ability to attain certain performance (Bandura, 1986). The students were motivated and showed higher self-efficacy when they constructed knowledge through the activities during the science fair. In science learning, active learning and social interaction help to internalize new or complex understandings, problems, and processes (Glasson, 1993). Furthermore, the activities conducted during the science fair also highlighting the science learning value such as problem-solving, science inquiry, critical thinking skills, and the relevance of science in daily life. As the students perceived the values of science, they were motivated to learn science (Tuan et al., 2005).

All the activities (such as experiments, workshops, and hands-on activities) conducted during the science fair have their objectives and goals. Performance goal (Tuan et al., 2005; Williams & Williams, 2011) and achievement goal will motivate the students to perform better (Covington, 2000). When the students are intrinsically motivated, they will have the motive to accomplish the goal in order to satisfy their innate desire (Deci & Ryan, 1991).

Generally, the learning of scientific knowledge happens in the classroom, the knowledge acquired is often disconnected from the real world. According to the situated learning theory, the learning process requires social interaction and the knowledge has to be delivered in an authentic context (Lave & Wenger, 1991). Authentic context promotes learning effectiveness (Anderson, 2004). Research has indicated that when the students' science learning motivation was enhanced when they were learning in an authentic context (Hung, Hwang, & Huang, 2012; Tseng, Tuan, & Chin, 2009). KLESF: The Fair 2017 managed to provide learning environment stimulation to the students, hence, the students were motivated to learn science.

Motivation has significant positive influences on science learning (Liu, Horton, Olmanson, & Toprac, 2011; Milner, Templin, & Czerniak, 2011). Students science knowledge scores increased significantly when their motivation scores increased (Liu et al., 2011). Hence, it is important to motivate the students to learn science.

Li and Tsai (2013) have stated that games-based learning able to raise students' motivation in science learning and promote science education. According to Chen, Darst, and Pangrazi (2001), learning activities that are novel, challenging, require exploration and attention provide instant enjoyment can trigger the students' interest. The activities that conducted during the KLESF: The Fair 2017 such as science experiments demonstration, science workshops, hands-on experiments, science projects competition, science magic show, and science exhibition were novel, challenging, require exploration and attention and provide instant enjoyment to the students, hence, these activities managed to trigger the students' interest, motivation and engage the students. From the finding, the students like and engaged to the activities in the KLESF: The Fair 2017. Interest leads to engagement, motivation, and learning (Renninger & Hidi, 2016; Walkington & Bernacki, 2014). When the students perceived the values and the relevance of science to daily life, they were motivated to learn science (Tuan et al., 2005) and this could lead them to pursue a science career in the future.

The findings also showed that KLESF: The Fair 2017 was interesting, fun, and enjoyable. Many students commented that they were able to learn and remember the science knowledge easily. They had a deeper impression on the knowledge learned as they could learn by doing and experiencing. Traditional teaching is the typical teaching method practiced in most of the schools; it is teacher-centred, and it lacks in interaction and engagement (Khalaf & Zin, 2018). On the other hand, KLESF: The Fair 2017 had a lot of active learning activities that can provide fun learning, therefore, KLESF: The Fair 2017 can promote and motivate the learning of science. According to Fleming's VARK model, learners learn effectively when the teaching methods used matched with their learning style. The activities conducted during the KLESF: The Fair 2017 can cater to all learning styles. Thus, the students were able to learn effectively through the activities in the KLESF: The Fair 2017.

The implications of KLESF: The Fair 2017 are far-reaching and diverse. Educators, researchers, stakeholders, government, and communities are encouraged to work hand in hand and organize more science fairs in the future in order to promote, sustain, and increase student motivation in science learning. If the students' interest in science is triggered earlier and they are motivated to learn science, they might be choosing science majors during their high school, this may eventually lead them to pursue science-related careers.

The duration of the KLESF: The Fair 2017 was the major limitation. KLESF: The Fair 2017 was a 3-day event, hence the length of the activity was constrained. Some of the students may not have enough exposure to science activities. In future study, the duration of the science fair can be extended, and it would be very worthwhile to investigate the long-term impact of KLESF: The Fair on the students' motivational and attitudes toward science learning. Despite the duration of the KLESF: The Fair 2017 was short, the fact that KLESF: The Fair significantly motivated the students in science learning is a promising result.

CONCLUSION

KLESF: The Fair 2017 has significant influences on the students' motivation toward science learning. The students were engaged to the KLESF: The Fair 2017, they gained new knowledge from the science fair. Science fair positively influenced the students' desire to pursue a science-related career. KLESF: The Fair 2017 was found to be interesting, fun, attractive, and enjoyable. The activities conducted during the science fair may enhance the science learning of students. The students commented that they had a deeper impression on the knowledge learned as they could learn by doing and experiencing.

ACKNOWLEDGEMENT

The authors greatly appreciate the students from the three secondary schools who volunteered to participate in this research. The authors are also grateful to the teachers in the schools who helped to distribute and collect the survey forms.

REFERENCES

Academy of Science Malaysia. (2018). *Science Outlook 2017*. Kuala Lumpur, Academy of Sciences Malaysia.

Alsop, S., Bencze, L. & Pedretti, E. (2005). *Analyzing exemplary science teaching: theoretical lenses and a spectrum of possibilities for practice*. London: Open University Press.

Andersen, C. (2004). Learning in "as-if" worlds: Cognition in drama in education. *Theory into Practice, 43*(4), 281–286. doi:10.1207/s15430421tip4304_6

Areepattamannil, S., & Kaur, B. (2012). Factors predicting science achievement of immigrant an non-immigrant students: A multilevel analysis. *International Journal of Science and Mathematics Education, 11*(5), 1183–1207. doi:10.1007/s10763-012-9369-5

Bandura, A. (1986). *Social foundations for thought and action*. Englewood Cliffs, NJ: Prentice-Hall.

Boghossian, P. (2006). Behaviorism, constructivism, and socratic pedagogy. E*ducational Philosophy and Theory, 38*(6), 713-723. doi.org/10.1111/j.1469-5812.2006.00226.x

Breiner, J. M., Harkness, S. S., Johnson, C. C., & Koehler, C. M. (2012). What is STEM? A discussion about conceptions of STEM in education and partnerships. *School Science and Mathematics, 112*(1), 3–11.

Burguillo, J. C. (2010). Using game theory and competition-based Learning to stimulate student motivation and performance. *Computers & Education, 55*(2), 566–575. doi:10.1016/j.compedu.2010.02.018

Chen, A., Darst, P. W., & Pangrazi, R. P. (2001). An examination of situational interest and its sources. *British Journal of Educational Psychology, 71*(3), 383–400. doi:10.1348/000709901158578

Chute, E. (2009). *STEM education is branching out*. Pittsburgh, PA, Pittsburgh Post-Gazette. Retrieved from: https://www.post-gazette.com/news/education/2009/02/10/STEM-education-is-branching-out/stories/200902100165. Accessed on 13th April 2019

Cicuto, C. A. T., & Torres, B. B. (2016). Implementing an active learning environment to influence students' motivation in biochemistry. *Journal of Chemical Education, 93*(6), 1020–1026. doi:10.1021/acs.jchemed.5b00965

Covington, M. V. (2000). Goal theory, motivation, and school achievement: An integrative review. *Annual Review of Psychology, 51*(1), 171–200. doi:10.1146/annurev.psych.51.1.171

Deci, E., & Ryan, R. (1991). A motivational approach to self: Integration in personality. In R. Dienstbier (Ed.), *Nebraska Symposium on Motivation, Volume 38, Perspectives on Motivation* (pp. 237–288). Lincoln, NE: University of Nebraska Press.

Deloitte Access Economics. (2014). *Australia's STEM workforce: A survey of employers*. Office of the Chief Scientist, Australian Government.

Dhanapal, S., & Evelyn Wan, Z. S. (2014). A study on the effectiveness of hands-on experiments in learning science among year 4 students. *International Online Journal of Primary Education, 3*(1), 29-40.

Dionne, L., Reis, G., Trudel, L., Guillet, G., Kleine, L., & Hancianu, C. (2011). Students' sources of motivation for participating in science fairs: An exploratory study within the Canada-wide science fair 2008. *International Journal of Science and Mathematics Education, 10*(3), 669–693. doi:10.1007/s10763-011-9318-8

Falk, J. H., & Storksdieck, M. (2005). Learning science from museums. *História, Ciências, Saúde-Manguinhos, 12*(suppl), 117–143. doi:10.1590/s0104-59702005000400007

Falk, J. H., & Storksdieck, M. (2009). Science learning in a leisure setting. *Journal of Research in Science Teaching, 47*(2), 194-212. doi:10.1002/tea.20319

Fisanick, L. M. (2010). *A descriptive study of the middle school science teacher behavior for required student participation in science fair competitions*. (Doctoral dissertation). Indiana University of Pennsylvania, Pennsylvania.

Fleming, N. *VARK: A guide to learning styles*. Retrieved from: http://vark-learn.com/

Freedman, M. P. (2000, September). *Using effective demonstration for motivation*. Retrieved from https://www.nsta.org/publications/news/story.aspx?id=40820

Gagne, M., & Deci, E. L. (2005). Self-determination theory and work motivation. *Journal of Organizational Behavior, 26*(4), 331–362. doi:10.1002/job.322

Glasson, G. (1993). Reinterpreting the learning cycle from a social constructivist perspective: A qualitative study of teachers' beliefs and practices. *Journal of Research in Science Teaching, 30*(2), 187–207. doi:10.1002/tea.3660300206

Glynn, S. M., Brickman, P., Armstrong, N., & Taasoobshirazi, G. (2011). Science motivation questionnaire II: Validation with science majors and nonscience majors. *Journal of Research in Science Teaching, 48*(10), 1159–1176. doi:10.1002/tea.20442

Gomez, K. (2007). Negotiating discources: Sixth-grade students' use of multiple science discources during a science fair presentation. *Linguistics and Education, 18*, 41–64.

Grinnell, F., Dalley, S., Shepherd, K., & Reisch, J. (2017). High school science fair and research integrity. *PLOS ONE, 12*(3), e0174252. doi:10.1371/journal.pone.0174252

Hung, C. M., Hwang, G. J., & Huang, I. (2012). A project-based digital storytelling approach for improving students' learning motivation, problem-solving competence and learning achievement. *Educational Technology & Society, 15*(4), 368–379.

John, M., Bettye, S., Ezra, T., & Robert, W. (2016). A formative evaluation of a Southeast High School Integrative science, technology, engineering, and mathematics (STEM) academy. *Technology in Society, 45*, 34–39. doi:10.1016/j.techsoc.2016.02.001

Jolly, E., Campbell, P., & Perlman, L. (2004). *Engagement, Capacity and Continuity: A Trilogy for Success GE Foundation.* Retrieved from http://www.campbell-kibler.com/trilogy.pdf

Khalaf, B. K., & Zin, Z. B M. (2018). Traditional and inquiry-based learning pedagogy: A systematic critical review. *International Journal of Instruction, 11*(4), 545-564. doi:10.12973/iji.2018.11434a

Kivunja, C. (2015). Exploring the pedagogical meaning and implications of the 4Cs "Super Skills" for the 21st century through Bruner's 5E lenses of knowledge construction to improve pedagogies of the new learning paradigm. *Creative Education, 6*(2), 224–239. doi:10.4236/ce.2015.62021

KLESF. (n.d.). Retrieved from https://www.klesf.net/welcome/

KLESF: The Fair 2015 (2015). *Horizon*, Issue 6/2015, 10-11.

KLESF: The Fair 2016 (2016). *Horizon*, Issue 6/2016, 10-11.

Korkmaz, H. (2012). Making science fair: How can we achieve equal opportunity for all students in science? *Procedia - Social and Behavioral Sciences, 46*, 3078–3082. doi:10.1016/j.sbspro.2012.06.014

Kuo, W. J., Liu, C. J., & Leou, S. A. (2012). Promoting female students' learning motivation towards science by exercising hands-on activities. *US-China Education Review B, 6*, 572-577.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge, England: Cambridge University Press. doi:10.1017/CBO9780511815355

Lee, M., Yun, J., Pyka, A., Won, D., Kodama, F., Schiuma, G., … Zhao, X. (2018). How to respond to the fourth industrial revolution, or the second information technology revolution? Dynamic new combinations between technology, market, and society through open innovation. *Journal of Open Innovation: Technology, Market, and Complexity, 4*(3), 21. doi:10.3390/joitmc4030021

Lee, S. W., Hong, L. P. & Mohd, Y. S. (2014). Kuala Lumpur Engineering and Science Fair (KLESF): A students' interest in science and technology enhancement programme. *Journal of Sciences and Technology in the Tropics, 10*, 75-80.

Li, M. C., & Tsai, C.-C. (2013). Game-based learning in science education: A review of relevant research. *Journal of Science Education and Technology, 22*(6), 877–898. doi:10.1007/s10956-013-9436-x

Lin, J. L., Cheng, M. F., Chang, Y. C., Li, H. W., Chang, J. Y., & Lin, D. M. (2014). Learning activities that combine science magic activities with the 5E instructional model to influence secondary-school students' attitudes to science. *Eurasia Journal of Mathematics, Science & Technology Education, 10*(5), 415-426.

Liu, M., Horton, L., Olmanson, J., & Toprac, P. (2011). A study of learning and motivation in a new media enriched environment for middle school science. *Educational Technology Research and Development, 59*(2), 249–265. doi:10.1007/s11423-011-9192-7

Los, R., & Schweinle, A. (2019). The interaction between student motivation and the instructional environment on academic outcome: A hierarchical linear model. *Social Psychology of Education*. doi:10.1007/s11218-019-09487-5

McCarthy, D. L. (2015). A science fair partnership: An active learning experience for teacher candidates. *Journal of College Science Teaching, 45*(2), 36-40.

Milner, A. R., Templin, M. A., & Czerniak, C. M. (2011). Elementary science students' motivation and learning strategy use: Constructivist classroom contextual factors in a life science laboratory and a traditional classroom. *Journal of Science Teacher Education, 22*(2), 151–170. doi:10.1007/s10972-010-9200-5

Ministry of Education Malaysia (MOE). (2013). *Malaysia Education Blueprint 2013–2025.* Putrajaya, MOE.

Ndlovu, M. (2014). *Investigating some background factors affecting student participation in science fairs: A case study of a regional expo for young scientists*. ICERI2014 Proceedings 7th International Conference of Education, Research and Innovation, Seville, Spain, 17th-19th November 2014. Spain, IATED Academy.

Noe, R. A., Wilk, S. L., Mullen, E. J., & Wanek, J. E. (1997). Employee development: Construct validation issues. In J. K. Ford, S. W. J. Kozlowski, K. Kraiger, E. Salas & M. S. Teachout (Eds.), *Improving training effectiveness in work organizations* (pp. 153–189). Mahwah, NJ: Lawrence Erlbaum Associates.

Office of the Chief Scientist. (2016). *Australia's STEM Workforce: Science, Technology, Engineering and Mathematics*. Australian Government, Canberra.

Palmer, D. (2007). What is the best way to motivate students in science? *Teaching Science: The Journal of the Australian Science Teachers Association, 53*(1), 38-42.

Peter, R., & Ron, Z. (2011). The judge's perspective: The secrets to a successful science fair. *The Science Teacher*, 44-46.

Renninger, K. A., & Hidi, S. (2016). *The power of interest for motivation and engagement*. New York, US: Routledge/Taylor & Francis Group.

Rosicka, C. (2016*). From concept to classroom: Translating STEM education research into practice*. Victoria, Australian Council for Educational Research (ACER).

Rukavina, S., Zuvic-Butorac, M., Ledic, J., Milotic, B., & Jurdana-Sepic, R. (2012). Developing positive attitude towards science and mathematics through motivational classroom experiences. *Science Education International, 23*(1), 6-19.

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and facilitation of intrinsic motivation, social development and well-being. *American Psychologist, 55*(1), 68–78. doi:10.1037/0003-066X.55.1.68

Sahin, A. (2013). STEM clubs and science fair competitions: Effects on post-secondary matriculation. *Journal of STEM Education, 14*(1), 5-10.

Said, O., & Cakiroglu, J. (2011). Effects of hands-on activity enriched instruction on students' achievement and attitudes towards science. *Journal of Baltic Science Education, 10*(2), 87-97.

Schmidt, K. M. (2014). *Science fairs and Science Olympiad: Influence on student science inquiry learning and attitudes toward STEM careers and coursework*. (Doctoral dissertation). Northern Illinois University, United States.

Schmidt, K. M., & Kelter, P. (2017). Science fairs: A qualitative study of their impact on student science inquiry learning and attitudes toward STEM. *Science Educator, 25*(2), 126-132.

Sonnert, G., Sadler, P., & Michaels, M. (2013). Gender aspects of participation, support, and success in a state science fair. *School Science and Mathematics, 113*(3), 135–143. doi:10.1111/ssm.12007

Suhanna Zainudin, Lilia Halim, Zanaton Iksan. (2015). How 60:40 policy affects the development of science curriculum in Malaysia. *Proceeding: 7th International Seminar on Regional Education*, Volume 3, (pp. 1396-1405). Educational Community and Cultural Diversity.

Sumrall, W., & Schilinger, D. (2004). Non-traditional characteristics of a successful science fair project. *Science Scope, 27*(6), 20–24.

Sun, L., Bradley, K. D., & Akers, K. (2012). A multilevel modelling approach to investigating factors impacting science achievement for secondary school students: PISA Hong Kong sample. *International Journal of Science Education, 34*(14), 2107–2125. doi:10.1080/09500693.2012.708063

Swackjamer, L. E., Koellner, K., Basile, C. & Kimbrough D. (2009). Increasing the self-efficacy of inservice teachers through content knowledge. *Teacher Education Quarterly*, *36*(2), 63-78.

The Scottish Government. (2017). *Science, Technology, Engineering and Mathematics (STEM) evidence base*. Edinburgh, The Scottish Government. Retrieved from https://www.gov.scot/publications/science-technology-engineering-mathematics-education-training-strategy-scotland/. Assessed on 13 April 2019

Tortop, H. S. (2013). Science teachers' views about the science fair at primary education level. *Turkish Online Journal of Qualitative Inquiry, 4*(2), 56-64.

Tortop, H. S. (2014). Examining of the predictors of pre-service teachers' perceptions of the quality of the science fair projects in Turkey. *Necatibey Faculty of Education Electronic Journal of Science and Mathematics Education, 8*(1), 31-44.

Tseng, C., Tuan, H., & Chin, C. (2009). Investigating the influence of motivational factors on conceptual change in a digital learning context using the dual-situated learning model. *International Journal of Science Education, 32*(14), 1853–1875. doi:10.1080/09500690903219156

Tuan, H., Chin, C., & Shieh, S. (2005). The development of a questionnaire to measure students' motivation towards science learning. *International Journal of Science Education, 27*(6), 639–654. doi:10.1080/0950069042000323737

Valerie, F. (2013). *Can participation in a school science fair improve middle school students' attitudes toward science and interest in science careers*? (Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses database. (UMI No. 3570455)

Vainikainen, M. P., Salmi, H., &Thuneberg, H. (2015). Situational interest and learning in a science center mathematics exhibition. *Journal of Research in STEM Education, 1*(1), 15-29.

Vygotsky, L.S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.

Walkington, C. A., & Bernacki, M. L. (2014). Motivating students by 'Personalizing' learning around individual interests: A consideration of theory, design, and implementation issues. In S. A. Karabenick & T. C. Urdan (Eds), *Advances in Motivation and Achievement, vol: XVIII, Motivational Interventions* (pp. 139–177). Bingley, UK: Emerald.

Wartinger, P. H. (1999). *Student science projects and science fairs: How to maximize benefits to students and minimize burden to teachers*. Education and Human Development Master's Theses.

Williams, K.C., & Williams, C. C. (2011). Five key ingredients for improving student motivation. *Research in Higher Education Journal*, *12*, 1-23.

World Economic Forum. (2018). *The Future of Jobs Report 2018*. Switzerland, World Economic Forum.

Xie, Y., Fang, M., & Shauman, K. (2015). STEM education. *Annual Review of Sociology, 41*(1), 331–357.

Yasar, S., & Baker, D. (2003). The impact of involvement in a science fair on seventh grade students. Paper presented at the Annual Meeting of the National Association for Research in Science Teaching (Philadelphia, PA, March 23-26, 2003)