

Sustaining Interest in Stem: New Norm in Enrichment Program

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Abstract

Digital transformation is not a novel phenomenon. However, Covid-19 pandemic has initiated digital transformation tremendously and has led to novelty in education due to global shutdown of several activities, including STEM-based enrichment programs. During the outbreak of Covid-19, all the enrichment programmes conducted physically were changed to online mode to provide sustainable learning among the students. Thus, this study aims to investigate the effectiveness and perception of enrichment programme which was conducted in online mode for gifted and talented students. Twenty gifted and talented students from Be A Scientist module, aged 9 to 12 years old were selected as the respondents of this research. The respondents participated in the Summer Camp Program, organized by Pusat GENIUS@Pintar Negara, UKM. Mixed mode approach was used, where the data were collected quantitatively and qualitatively. Data for quantitative study were collected as pre and post-test, while data for qualitative study were obtained based on perception of the students and parents via online survey. Students' interest was found to be a crucial role in engaging the students with learning activities regardless online or face-to-face mode. However, parents' choice was to face-to-face teaching and learning, since the effectiveness of the program can be evaluated clearly than online mode.

Keywords: enrichment program, STEM, online, gifted students

1. Introduction

1.1 Why is STEM important? Or The importance of STEM

In today's competitive world, most countries need highly skilled and knowledgeable laborers. The need to improve STEM education is particularly salient as the demand for skilled

workforce in STEM fields grows (Litzler et al., 2014) in developed and developing countries. Researchers suggest that the crucial way to develop such skills is by reinforcing the competence of students in STEM at school level (Carter, 2013). Thus, in order to fulfil this requirement, today's education system has become increasingly challenging for both students and institutions, especially in STEM.

Studies found that in the early years of education, students who have a high interest in science, mathematics, and engineering are more likely to continue their career in a STEM related field (After School Alliance, 2015). This was further supported by PCAST (2010), stating that students' desire to pursue a STEM career grows when their interests in STEM increase. However, some students may choose not to pursue STEM careers by assuming that STEM subjects are too challenging, not interesting and boring (PCAST, 2010). Moreover, studies also expressed that limited exposure to STEM (Christensen & Knezek, 2017) and lack of knowledge about STEM (Prieto & Dugar, 2017) may limit selection of career in the STEM related field. Thus, Vela et al. (2020) proposed that engagement in an informal STEM camp during secondary education plays a crucial role to feed essential knowledge about STEM related fields and the benefits of STEM careers that students need to know to make future decisions.

As the years go by, various initiatives have been taken by countries all over the world to increase student's interest in selecting STEM related fields as careers in order to meet demands. In the Malaysia Education Blueprint (2013-2025), strengthening STEM has been identified as one of the key elements. The main goal of the STEM initiative is to ensure that Malaysia has a sufficient number of qualified STEM graduates to meet the employment needs of the industry which serves as the country's economic engine (Ministry of Education, 2013). In line with the Malaysia Education Blueprint (2013-2025), it is crucial to put great emphasis on quality STEM education in schools by increasing instructional time and practical application. Exposing students to STEM through enrichment programs should be encouraged in order to build their passion and curiosity especially when these concepts are inculcated in their daily lives.

1.2 Gifted students and enrichment programs

Enrichment programs are diversification and addition to the formal curricula of the regular students in order to meet the needs of the gifted and talented students in terms of their cognitive skill, affective, creative, and psychomotor fields (Van Tassel-Baska & Brown, 2007). STEM enrichment programs advance students from traditional school settings to access authentic scientific knowledge and practices and provide more valuable opportunities. Sebring and Tussey (1992) stressed that enrichment programs are a set of activities, experiences, and subject matters that could bring the gifted and talented students beyond the traditional

curriculum, by answering their curiosity, confronting their capabilities and occupying their time beneficially. In another study, the finding of the research indicates that science enrichment summer programs for gifted students in Finland provides fresh knowledge and creative insights into various fields of interest as well as information and communications technology. Since science attitudes are strongly correlated to long-term science achievement as highlighted by Weinburgh (1995), the advancement of positive science attitudes is essential.

In another study, Bellamy and Sturgis (2005) revealed a significant correlation between emotional intelligence and self-efficacy among 98 gifted and talented high school students who participated in a two-week summer educational program. Stake (2005) evaluated the impact of summer science enrichment programs on 88 gifted students from 38 high schools in a Midwestern metropolitan area. The findings show that the students gain confidence and motivation via the science programs. The students also expressed that knowledge about science processes and content has increased after attending the program.

Luehmann (2009) studied 292 secondary students' (ages 11–18 years) perspectives of a science enrichment program. The result revealed that attentively designed science enrichment programs have the potential to broaden students' experiences of science along bridge them to school science. In the United States, STEM enrichment programs conducted among numerous college and university students shows that enrichment programs have positive effects in terms of student performance, interest in science, research experiences and increase the degree to which students identify as scientists (Merolla & Serpe, 2013). Moreover, Alzoubi (2014) revealed a significant academic skill improvement among gifted and talented students participating in an enrichment program in Jordan. Similar findings were also obtained in a study conducted with 180 participants in Singapore, where enrichment activities relevant to school science were found to improve science achievement (Cheong & Swee, 2008). Therefore, enrichment programs, particularly to gifted and talented students, should be encouraged in order to heighten higher order thinking and develop potentials embedded in themselves which later may benefit the country.

Baska (1989) asserted that gifted learners are those who display curiosity, sustained interest, have an unusually well-developed memory, desire to work independently, and are capable of generating new ideas. However, Renzulli (2005) pointed the characteristics of gifted learners as the ability to understand complex or abstract topics easily, learn more rapidly than similar age group, good problem solving skills and advanced verbal ability. Once the gifted students were identified via various processes, the field they are most interested in and the most talented area, the discipline in which they have the most interest and display the most talent can be ascertained. Thus, nourishment of critical thinking skills and creativity has become the crucial step in the development of scientifically gifted students. Enrichment programs are proven measures to foster gifted students' talent and achievement (Ulger & Çepni, 2020). Ulger and Çepni (2020) emphasized that if gifted students show accomplishment

and talent in science fields, such as biology, chemistry and physics, they are recognized as scientifically talented.

Researchers found that a proper nurturing of gifted students will allow them to blossom and grow into their inherent potential. In order to overcome the limits of school curricula and facilitate the lure of science and research, Renzulli and Reis (2002) have developed the Schoolwide Enrichment Model (SEM). The SEM has successfully provided the opportunity for the students to develop giftedness and talents and to assist them with life-long learning and culminating, which will result in higher levels of creative and innovative work in the field of their interest (Renzulli & Renzulli, 2010). Based on previous studies, enrichment programs have been used as a tool to enhance gifted and talented students' knowledge, motivation and ultimately, develop their capabilities and talents (Cannon, 2005). Thus, this study was carried out for gifted and talented students at Pusat GENIUS@pintar Negara in Malaysia to observe the perception on the enrichment program which was conducted in new norm, not only by translating the face-to-face module, but provide content by which the learner is able to engage with minimal support.

1.3 Pusat GENIUS@pintar Negara School Holiday Camp Program

As gifted students have their unique giftedness and talent in peculiar areas, it is essential that these students are provided with individually designed programs to match their own learning needs (Wu, 2013). Proper nurturing will allow children to blossom and grow into their inherent potential. The spread of COVID-19 has led several educational institutions to end face-to-face education and temporarily close all over the world in 2020 and 2021. This also has caused a negative impact on educational activities, as social distance is vital at this stage (Dhawan, 2020). Many educational institutions have become interested in finding alternative ways to manage this difficult circumstance with their best by delivering course content online, engaging learners and in conducting assessments (Mukhtar et al., 2020). Similarly, by considering the pandemic situation, Pusat GENIUS@pintar Negara in Malaysia also has planned and conducted the School Holiday Camp using the online mode which has become the new norm.

The School Holiday Camp program offers courses for primary and secondary students. Courses offered at the primary levels are Introduction to Cryptology, Introduction to Robotics, Computer Programming, Fast-Paced Biology, Logical Reasoning, Being a Scientist, Invention, and Crime Scene Investigation. On the other hand, Cryptology, Crystal and Polymer, Statistics, Star Rangers, Clinical Laboratory Science, Forensic Science, Camera and Telescope, DNA Barcoding, Probability and Game Theory, Green Technology, and Genetic Engineering are offered for secondary level. The programs offered in this school holiday camp program are new subject areas which challenge and create interest of the gifted and talented students in

STEM. Thus, this study aims to analyse how the enrichment program was conducted in online mode and the perception of the students participated in the online enrichment program.

2. Methodology

2.1 Respondents

The respondents of this research comprised of 20 gifted and talented students who attended the 'Be A Scientist' course organised by Pusat GENIUS@Pintar Negara, located in Selangor, Malaysia. All the selected respondents were primary school students (aged 9 to 12 years old) from all over Malaysia.

2.2 Data collection

This study employed both quantitative and qualitative approaches to obtain the required data. Informed consent was obtained from all the respondents prior to data collection. For the quantitative approach, data were obtained via pre-post-test. This study focused on particularly 'Be A Scientist' module. Before the start of the School Holiday Camp program, students were given a pre-test. The pre-test was conducted to determine the gifted and talented students' level of knowledge about the content of the 'Be A Scientist' module. 'Be A Scientist' Module covers a total of eight topics, namely You Could Be A Scientist, Our Earth, Plant Science, The Chemistry of Soap, Mini Ecosystem, Geology, Respiration and Forensic Science.

Since the traditional method of teaching and learning is no longer efficient, student-based learning was used throughout the School Holiday Camp program. Student-based learning was used during the interactive teaching and learning process, which consisted of independent learning (pre-class reading), presentation of topic, inquiry-based learning, problem-based learning, small group discussion, presentation and laboratory activities to improve students' understanding. At the end of the camp, the post test was given as an assessment test, to gauge the students' knowledge after the course. The collected data from the pre-post-test were analysed using descriptive analysis, t-test and One-way ANOVA test with IBM's Statistical Packages for Social Science (SPSS) v23 software.

On the other hand, in the qualitative approach the feedback from the students and parents were obtained. The feedback form was prepared in which the feedback covers the students' opinion on pre-post tests and overall effectiveness of the program as well as suggestions from parents. Parents were also asked to provide in-depth emerging new ideas and suggestions about the program. With the consent of the respondents, all the feedback and emerging new ideas or suggestions were recorded.

The data obtained from students were analysed thematically using Atlas.ti 7.0 software. The feedback data were encoded based on themes and sub-themes. The selection of prospective themes and the formation of sub-themes were developed based on the feedback obtained from the students. The relationships between themes and sub-themes were laid out for the formulation of the relationship between the enrichment program and the students’ feedback.

3. Results and Discussion

3.1 New norm in enrichment program: The school holiday camp program

The School Holiday Camp program conducted by Pusat GENIUS@Pintar is a yearly planned enrichment program aimed to help the students to increase their potential via various courses offered. This program intends to develop students’ current talents and abilities, nature students’ potential holistically, beside flourish students’ skills for lifelong learning (Lani et al., 2021). Table 1 represents the structure difference between the similar School Holiday Camp program which was conducted in face-to-face mode before pandemic and online mode during pandemic. In the new norm, program duration, class duration and type of outdoor activity were changed in order to encourage the students to stay focused throughout the program. However, the selection of students for online and face-to-face mode was based on the UKM 1 and UKM 2 screening test. Moreover, both face-to-face and online mode course were carried out using differentiated instruction. This is because differentiated instruction enables the instructor to adjust the learning needs of the students up to the maximum potential (Buttler & Lowe, 2010), besides make the students motivated and enthusiastic in learning (McAdamis, 2001).

Table 1: Difference between face to face and online mode

	Face to face	Online
Program Duration	3 weeks	10 days
Class Duration	8.30 am – 4.30 pm	9.00 am – 4.00 pm
Students age	9-15 years	9-15 years
Teaching mode	Student-centred	Student-centred
Screening test	UKM 1, UKM 2	UKM 1, UKM 2
Instruction mode	Differentiated instruction	Differentiated instruction
Course conductors	Instructor Teaching Assistant Student Assistant	Instructor Teaching Assistant Student Assistant
Outdoor activity	Trip	Virtual activities

3.2 Pre-post Test

Table 2 shows the result for Wilcoxon signed-rank test analysis for pre and post test. The pre and post tests consist of questions from the ‘Be A Scientist Module’ content which

was conducted virtually. All 20 students answered the pre-test before the activities started on the first day of the School Holiday Camp Program and the same questions were given on the last day of the camp upon completion of 'Be A Scientist' module. When answering the pre-test for 'Be A Scientist Module', the students are not expected to answer all the questions. However, prediction of rational answers based on previous knowledge is encouraged.

A Wilcoxon signed-rank test shows that the ten days of the 'Be A Scientist Module' course elicit a statistically significant difference in the participating students' knowledge for the pre and post test ($Z = -3.729$, $p < 0.05$). The result also indicates that the 'Be A Scientist' module provides a significant effect on the knowledge of the students, even though it was conducted in online mode. This result is supported by the median value of the Boxplot graph for the pre and post test (Figure 1). The result indicates that the test scores for both pre and post are distributed. However, from the Boxplot, the median score was found to be slightly more spread out in post-test scores compared to pre-test scores. This shows the students gain significant increase in knowledge after involvement in the School Holiday Camp Program. When taking the post test, students were expected to answer more questions correctly based on the increase in understanding and knowledge upon completion of the module.

Table 2: Wilcoxon signed-rank test analysis

Ranks			
	N	Mean Rank	Sum of Ranks
Negative Ranks	0 ^a	.00	.00
Post - Pre Positive Ranks	18 ^b	9.50	171.00
Ties	2 ^c		
Total	20		

- a. Post < Pre
- b. Post > Pre
- c. Post = Pre

Test Statistics^a	
	Post - Pre
Z	-3.729 ^b
Asymp. Sig. (2-tailed)	.000

- a. Wilcoxon Signed Ranks Test
- b. Based on negative ranks.

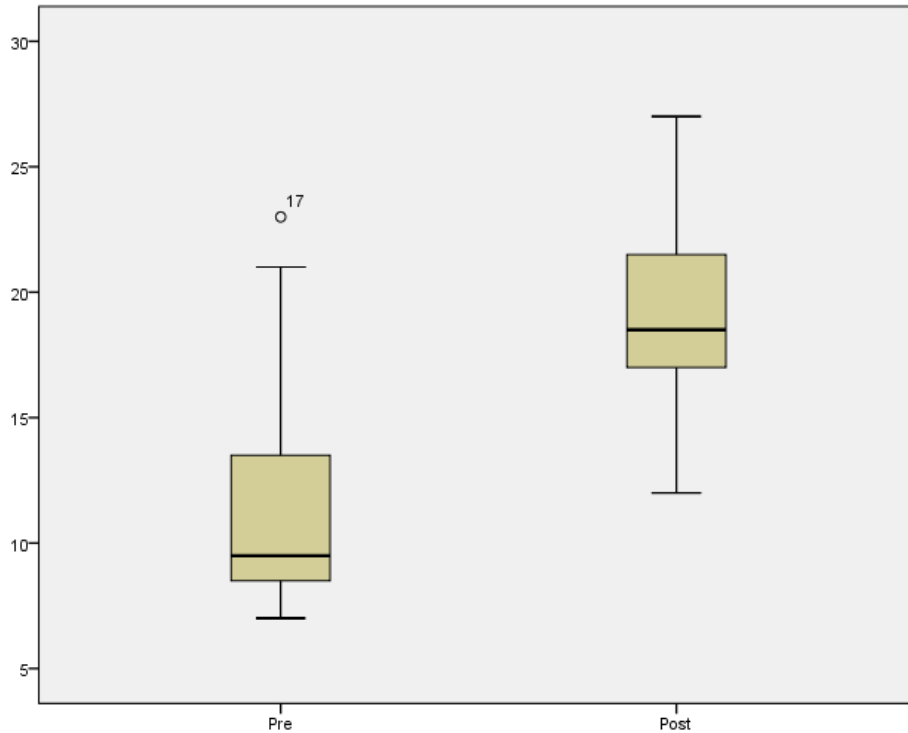


Figure 1: Boxplot graph for the pre and post test

3.3 Perception on Online School Holiday Camp Program

Results revealed that the majority of the students are of the opinion that the pre-test conducted at the beginning of the camp has helped to improve focus during the module and assist in better performance during the camp. Administering a pre- -test at the beginning of the module was found to increase the curiosity and eagerness among the students on what they are going to learn.

Figure 2 shows the relationship between the enrichment program and the students' feedback. The findings suggest that there are three main benefits obtained by the students, namely, knowledge, interest and personality traits. In terms of knowledge, students found the activities provided were fun and appropriate to their age. They also expressed that, by attending the 'Be A Scientist' module course, understanding about science increases besides acquiring new knowledge and exposure from different science fields. Moreover, in terms of interest, the offered program was found to stimulate interest towards science. The students also reveal that personality traits such as friendship building nature, confidence, new skills and time management attitudes have improved after the programs.

During the 'Be A Scientist' enrichment program, the student-centred approach has created a great impact on students' learning interest. From the analysis, it was found that students' knowledge is linked to their interest. Fastrich and Murayama (2020) state that learning or knowledge acquisition has a positive impact on interest development among the

participants. The importance of promoting interest in education was also supported by Harackiewicz et al. (2016). Harackiewicz et al. (2016) state that interest is the powerful motivational process to engage and gain learning experience among the students.

Moreover, personal traits are also found to be linked to students' interest. Feist (2006) highlighted that the first step to become a scientist is by showing interest in science. The study also revealed that development of personality traits impact directly and indirectly scientific thought, interest and achievement of the students. Overall, the success of an enrichment program highly depends on the interest of the students towards the selected field. A well designed online enrichment program is able to provide exceptional and personalised learning experiences for the gifted and talented students. Student-centred learning, interactive activities and feedback on students' performance after each activity during the new norm online enrichment programs able to develop independent learning skills among the students.

Although the students confidently state the benefits gained during the online enrichment program, it is important to have online or blended learning, the parents have voiced out their opinion, stating that not all of the students are ready to adopt the new norm of learning. Qualitative analysis of data from parents shows positive perception and suggestions. From positive aspect, parents state that:

- ... feel happy for the centre'' efforts in organizing school holiday programs online.*
- ...Online programs enhance a more comfortable learning environment for the children.*
- ...give students the opportunity to plan study time and rest time in a day*
- ...effective module to create interest in science*
- ...helps in enhancing their skill development*
- ...giving nice experience to explore fields related to future careers*

The analysis from this study suggests that generally the parents were satisfied with the enrichment program. Responses also indicate that the students become more disciplined in managing their time. Furthermore, the 'Be A Scientist' module was found to have created interest in science among the students, where the students had an opportunity to dive deep into their field of interests besides exploring new things in science. Indirectly, the module has enhanced the students' skills, while providing great experience to further explore fields related to their careers since young.

From positive aspect, parents state that:

- ...It basically broadens their knowledge, however would be more effective if conducted face to face*

...She is happy and made friends, it was really worth it for her. Looking forward to face-to-face program

... it would be great for my kids to be able to connect face-to-face

...helps to build a unique interest, but miss quality face-to-face time

Based on the analysis, it was observed that although the responses were found to be positive for the new norm enrichment program, the parents encourage face-to-face courses since it is able to provide greater experience and understanding to the students. Parents also expressed that face-to-face courses enable the students to interact with their instructors to broaden their knowledge. This opinion aligns with Miliszewska (2007), who states that face-to-face communication provides a more conducive learning process, by providing opportunity to interact and share knowledge. However, Sadeghi (2019) suggests that although online learning is found to be less effective as compared with conventional classroom learning under certain circumstances, it has not been claimed that online learning is able to replace traditional classroom learning. Thus, online learning could be utilised as an alternative choice under certain situation.

4. Conclusion

The presence of COVID-19 causes significant challenges for student's learning, where most of the students have been affected by not being able to physically attend school or any programs. Educational institutions also have adopted learning programs via a digital device which has become particularly important during online classes. Although online enrichment programs require the transfer of activity, planning and content from the traditional format to the online format, it was found that online enrichment programs have provided new experiences to the students. Statistically significant difference of the pre-post test result shows a significant improvement in terms of the students' knowledge upon completion of the ten-day enrichment program. The results obtained from this study show that students' interest plays a crucial role for the transition from traditional mode to online teaching and learning, and in providing a feeling of satisfaction during online courses. Moreover, the findings indicate that face-to-face lessons are the preferred choice by parents to develop the full potential of the students, yet online mode enrichment programs still can be conducted as an alternative choice. It must also be taken into consideration that proper planning, advancement in technology, stability of the internet connection and reflective activities are crucial for a successful online program. There are several limitations need to be acknowledged in this study. Future research need to be conducted with more participants who experience different STEM enrichment modules.

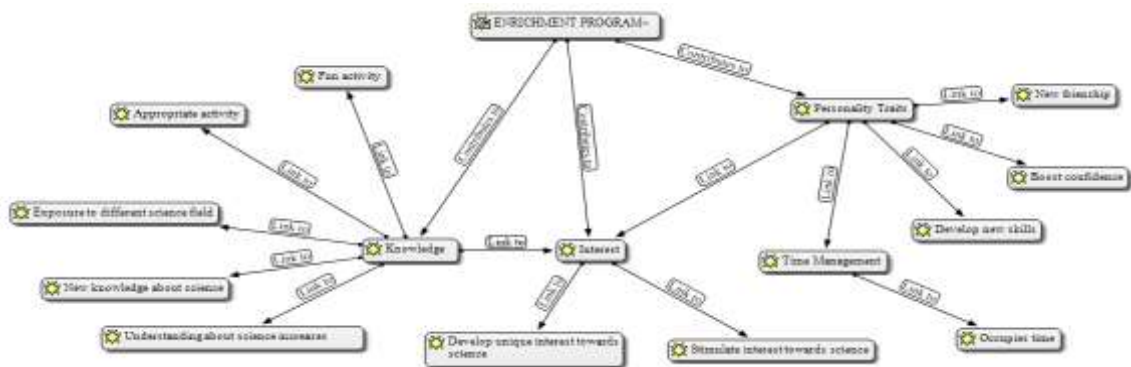


Figure 2: The relationship between Enrichment Program and the students' feedback Acknowledgment

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