

ICONSPADU 2021**International Conference on Sustainable Practices, Development and Urbanisation****IMPACTS OF ONLINE MATHEMATICS CLINIC PROGRAMME
IN IMPROVING PRE-UNIVERSITY STUDENTS' ACADEMIC
PERFORMANCE**

Hasnur Hidayah Kamaruddin (a)*, Norazah Mohammad Nawawi (b), Rahayu Md. Khalid (c),
Norazlina Hanim Shamsudin (d), Khairil Bariyyah Hassan (e), Norhisyam Mat Sout (f)

*Corresponding author

- (a) Centre for Foundation and General Studies, Universiti Selangor, Selangor, Malaysia. hhidayah@unisel.edu.my
(b) Centre for Foundation and General Studies, Universiti Selangor, Selangor, Malaysia. norazah@unisel.edu.my
(c) Centre for Foundation and General Studies, Universiti Selangor, Selangor, Malaysia. rahayu17484@unisel.edu.my
(d) Centre for Foundation and General Studies, Universiti Selangor, Selangor, Malaysia. lynnhanim@unisel.edu.my
(e) Centre for Foundation and General Studies, Universiti Selangor, Selangor, Malaysia. khbariyyah@unisel.edu.my
(f) Centre for Foundation and General Studies, Universiti Selangor, Selangor, Malaysia. syamms@unisel.edu.my

Abstract

Online education previously viewed as an option for those adult learners seeking higher education opportunities. However, Covid-19 pandemic has changed that view which has made educators and students from all levels of education adapt quickly to virtual courses. Nowadays, online teaching and learning has been used extensively by education institutions including Universiti Selangor. As a mathematics clinic programme is developed with the aim of helping students who find mathematics challenging and struggling to understand the related subjects, the need to run this virtual program effectively is even more important. Therefore, it is necessary to study the impact of attending a series of online mathematics clinic sessions on these respective students. In this research, students' academic performance is evaluated and their perception is statistically analysed. Pre and post-survey are given to students in Foundation in Management (FIM), Foundation in Information Technology (FIT) and Foundation in Science (FIS) who are the target groups of these clinics. Results from the study should be able to support the relationship which suggested that virtual mathematics clinic could be an effective initiative to increase their confidence and competence towards mathematics-related subjects. At the end of this study, it is also hoped that the development of virtual learning through these online mathematics clinics would not only improve the learning outcome, but also help to improve the sustainability of education as a whole beyond any subject or level of education.

2421-826X © 2022 Published by European Publisher.

Keywords: Academic performance, foundation students, online mathematics clinic, virtual learning

1. Introduction

Mathematics is an important subject studied by all ages and academic backgrounds. Learning mathematics at pre-university level is a gatekeeper requirement into many third level STEM courses (Johnson & O’Keeffe, 2016). The ability to understand mathematics is an important predictor of students’ potential at all levels of academic activity. Therefore, most university programmes especially in science designate it as a compulsory course. In recent years, it has been found that students’ basic mathematical abilities and readiness levels at the time of entry into higher education have declined significantly (Asshaari et al., 2012). Results in Program for International Student Assessment (PISA) 2009 showed that nearly 60% of the 15-year-old Malaysian students who participated in the assessment were below the minimum benchmarks of mathematical literacy (Wong & Wong, 2019).

In order to increase understanding and interest in mathematics, various efforts need to be made. It also aims to increase student engagement by introducing new learning methods, enhancing the skills of lecturers and increasing students’ awareness (Nawawi et al., 2021). In most basic mathematics classrooms, traditional teacher-led education is still the dominant approach. Under such circumstances, the teacher is rarely able to attend all of the students and may then continue to lag behind in mathematical achievement and lose interest in the subject, eventually giving up in learning mathematics (Yeh et al., 2019). In response to the global challenges, a mathematics clinic approach is introduced for weaker students so that they feel comfortable to share confusion and bridge the gap between the lecturers and students. In addition, this programme includes the opportunity of listening to students, encouraging peer tutoring, reviewing basic mathematical concept and guiding the calculation steps. Mathematics clinic programme for foundation students in Universiti Selangor mainly aimed for students taking several mathematical courses including Statistical courses. Initial implementation of this programme requires the commitment of students to meet the lecturer face to face and get attention on a one-to-one basis which allows students to feel comfortable as well as understand easily. However, this approach adjustable to the online medium due to the current pandemic situation.

2. Problem Statement

Covid-19 pandemic led to a sudden shutdown of many universities as well as other education institutions in 2020. It affects more than 1.6 billion students in over 190 countries around the world (Spitzer & Musslick, 2021). Lecturers, students and parents are required to adapt with a new home-schooling situation as everyday class cannot be resumed physically. As a result, online learning platforms can be seen as solutions to the new home-schooling situation and complement traditional classes. However, these dramatic changes give more physiological effects to the students. According to Adedoyin and Soykan (2020), lack of connectivity, bad internet infrastructure and outdated technological devices become major physical challenges to the students. In addition to students’ stressful new experience, distractions from family members, heavy assignment workload, and domestic obligation make them become less confident to pursue study in higher education. Obstacles faced by the students are much worse in technical and calculation subject. Not only to students, mathematics learning presents new challenges to lecturers due to difficulties in explaining mathematical concepts online (Irfan et al., 2020).

Behind all incidents happen, there is a silver lining on a dark cloud whereby the digital style of teaching and learning is practiced during this covid-19 pandemic. Lecturers have to work on new methods and applying new technologies. The usage of tablet pen, slides and various apps become basic necessities in the process of teaching and learning. Study from Eddie and Jose (2020) revealed that teachers who exhibit good tech-skills will engage in mathematics learning activities and help students in better understanding during virtual class. Meanwhile, results of the study from Muthuprasad et al. (2021) indicate that flexible schedule and convenience was ranked as the major benefits of the online learnings. Therefore, the Covid-19 trigger the lecturer to pursue the creative method to implement this mathematics clinic programme virtually. Various software or apps explored by lecturers such as Google Meet, Zoom, OWC, Skype, Webex, ClassPoint, myViewBoard, Quizziz, Padlet are used as online communication tools. Taking into account that students learn at different speeds and constraints, an online mathematics clinic is conducted to ensure every student's learning opportunity is protected.

A similar mathematics clinic concept was introduced not only by few universities in Malaysia. It is also conducted in several other countries and is not limited to mathematics subject only. There are also clinical programs for various science subjects such as chemistry, physics and others. According to the Ministry of Women's and Children's Affairs in Ghana, 40,908 girls participated in the STEM clinics between 1986 and 2010 (Ismail, 2018). Moreover, study by Settelmaier and Zadnik (2010) stated that STEM clinics were originally designed for students of physics, chemistry, mathematics and computing to identify students at risk early. Several works of literature support the positive impacts of mathematical clinic programme. For example, Santiago-Carrillo (2019) stated that mathematics clinic programme has strengthened students' interest for the different areas of knowledge. Despite much has been written about mathematics clinic programme, quantitative research investigating this programme conducted online remains limited. Therefore, this study will discover at how math clinic programme impact students' academic performance particularly via virtual approach.

3. Research Questions

The present study focuses on virtual mathematics clinic programmes which directly assess students on mathematics performance. This study is guided by the following research questions:

- i. What is the impact of online mathematics clinic sessions to the students' perception?
- ii. How does online mathematics clinic programme increase students' confidence level and competency, hence help the students in improving calculation subjects?

4. Purpose of the Study

The purpose of the study is to investigate students' perception on the impact of online mathematics clinic. This perception is related to the students' confidence and competency before and after attending a series of online mathematics clinic. Understanding the students' perception as mentioned leads to the theoretical implications on how online mathematics clinic strongly relate to the outcome which can help the students in sustaining their academic performance. This finding is beneficial to the foundation programme, faculty and university. This is because the results revealed the significant input to

complement students' knowledge, understanding and interest besides the normal lecture and tutorial. Similar clinic activity could be implemented in other courses especially for courses which have higher failure rate.

5. Research Methods

The research used a quantitative approach with pre-test and post-test design. This investigation was carried out during semester April 2021 on 77 students. Based on Figure 1 (a), the respondents consist of 44 female students and 33 male students. Out of 77 students, 13 students are from Foundation in Science (FIS), 29 students are from Foundation in Information Technology (FIT) and 35 students are from Foundation in Management (FIM) programme. Frequency of the students according to foundation programmes was revealed in Figure 1 (b).

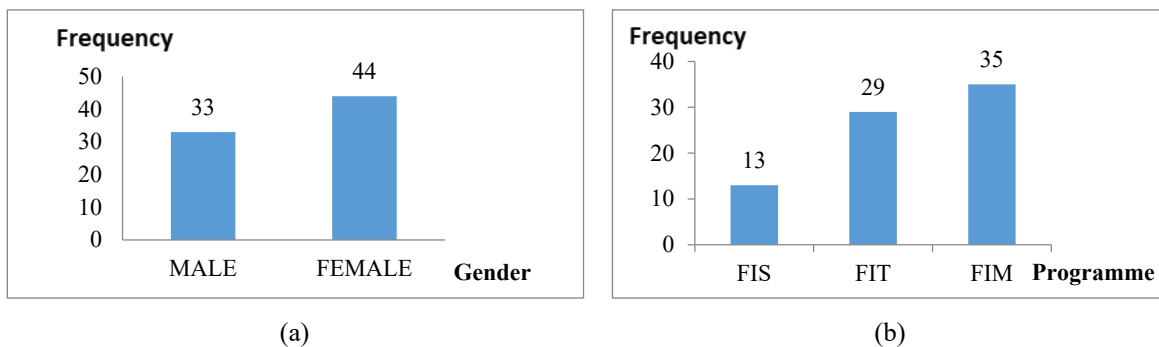


Figure 1. Frequency of respondents according to gender (a) and foundation programme (b)

The number of FIM students is the highest because the entry requirement to enter the programme is lower than the other two programmes. The entry requirement for FIM programme is five credits in any subjects whereas the entry requirement for FIS and FIT are five credits in any subject including Mathematics. Therefore, the basic mathematics knowledge and skills among students from FIS, FIT and FIM programmes are differentiable. This can also be shown from the variety of grades obtained for their mathematical course in previous semester (refer to Figure 2).

Data collection is started at the first week of lecture by giving pre-test survey to the respondents. It was to find out the initial score of students' perceptions towards online mathematics clinic. A series of mathematics clinic is carried out once a week for every group with a time allocation of 1 hour per session. This activity is not restricted virtually in the online platforms such as Google Meet, Unisel OWC (big blue button) and Zoom application. Instead, revisions on this subject also conducted in various forms such as online quizziz, one to one consultation via Whatsapp chat and elearning exercises for certain topics. In the last week of lecture, the researcher gave the students a post-test. The post-test was developed with the aim of knowing the final score of maths clinic impact towards students. Since this research is conducted during the covid-19 pandemic, data in pre-test and post-test were collected using an online survey. According to Irfan et al. (2020), online surveys are used for reasons of flexibility and easily managed by the lecturers using various devices. The researcher used a set of questionnaires consisting of statements measured using a Likert scale. The statement is used to measure students' confidence which is related to

what they believe in understanding mathematical concepts, handling calculation problems and ability to complete the task given during lectures, tutorials or assessments.

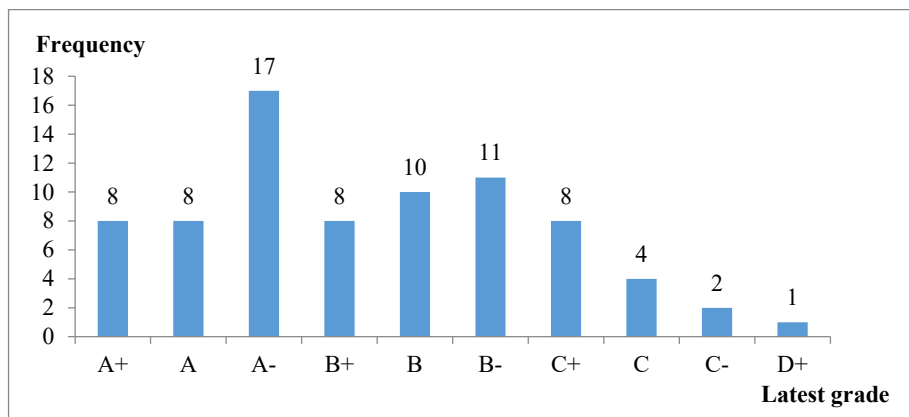


Figure 2. Frequency of respondents according to the latest grade for a mathematical course in the previous semester (Semester November 2020)

Initial analysis with descriptive statistics was used for two sections of the study followed by the paired t-test. Rahman and Johar (2021) also used paired sample t-test to determine whether there is a difference in the mean of pre-test and post-test for students' critical thinking skills before and after implementing Problem Based Learning model assisted by GeoGebra software. Similarly, the result for this study will be analysed using SPSS 25 to obtain information on the significant difference of the data. Criteria for acceptance or rejection of the hypothesis are based on the comparison of the t-value at 5% significance level.

6. Findings

6.1. Increasing students' confidence level towards Mathematics

The following Table 1 shows the frequency of students answering each statement in pre-test survey and post-test survey. The highest rank 5 indicates that students 'strongly agree' with the statement. Meanwhile, rank 4 and 3 represents that the students 'agree' and 'neutral' with the given statement respectively. If the students do not agree, they will answer the statement either 2 for 'disagree' or 1 for 'strongly disagree'.

Based on the result of SPSS analysis shown in Table 2, there is an increase in students' confidence level as indicated by the higher mean for Statement 1, 2 and 3 for post-survey. The average of 3.53 and 3.18 for pre-test indicates that most of the respondents partially agree that they are good in Mathematical subjects and they might have difficulties to solve the problems. As the mean calculated for statement 3 in pre-test is 3.91, some of the respondents are also still unsure that they can build up their confidence level by attending the online mathematics clinic this specific semester. However, students presented an improvement in the perceptions and interpretation as the value of mean for Statement 1, 2 and 3 for post-survey are inclined to 3.65, 3.45 and 4.10 respectively.

Table 1. Patterns of Answers to Indicate Students' Confidence in Learning Mathematics

No.	Indicators	Pre-test					Post-test				
		5	4	3	2	1	5	4	3	2	1
1	I know I can do well in mathematics.	11	26	37	1	2	14	26	34	2	1
2	When I have difficulties in mathematics, I know I can handle them.	4	16	44	11	2	10	22	39	5	1
3	Attending maths clinic can build my confidence in solving mathematical questions.	16	38	21	2	0	28	31	16	2	0

Table 2. Descriptive Measures on Students' Confidence Before and After Implementing Maths Clinic

Statement No.	N	Pre-test		Post-test	
		Mean	Std. Deviation	Mean	Std. Deviation
Statement 1	77	3.53	.804	3.65	.855
Statement 2	77	3.18	.773	3.45	.851
Statement 3	77	3.91	.798	4.10	.821

6.2. Increasing students' competency in learning Mathematical subjects.

The main purpose for this mathematics clinic programme is to accelerate the students' abilities and skills especially for weak students. Although some of these students obtained poor results during the school level, they actually have an opportunity to attain better grades at pre-university level with the support of colleagues and guidance from lecturers. According to Santiago-Carrillo (2019), mathematics clinic is a new medium that motivates students and cultivates a learning culture. This is because math clinics enable students to consult their weaknesses personally and prepare for the examination by doing more exercises. This view is not only given by the experts, but respondents in this study also agreed that mathematics clinic can help in improving students' skills. This is shown from the increase in the number of students who strongly agree for statement 4, 5, and 6 in the post- survey. Frequency of responses for pre-test and post-test is shown completely in Table 3.

According to Table 4, the mean and standard deviation for all statements in the pre-test has increased in the post-test. This indicates that students believe online mathematics clinic not only help in terms of students' confidence, but also students' competency in mathematical subjects such as Elementary Mathematics I, Elementary Statistics and Business Mathematics. Mathematical skills are not only important for mathematics related subjects but they also influence achievement in other subjects involving computation. For instance, physics or accounting might require students to master the calculation. Reddy and Panacharoensawad (2017) mentioned that Physics is apparently a contingent on mathematical language in the aspects of quantitative and qualitative calculations. Students who also pass more advanced secondary mathematics subjects perform significantly better in introductory business courses such as Financial Accounting and Introductory Finance (Alcock et al., 2008).

Table 3. Patterns of Answers to Indicate Students' Competency in Learning Mathematics

No.	Statement	Pre-test					Post-test				
		5	4	3	2	1	5	4	3	2	1
4	In my opinion, Mathematics attainment can be improved by visiting maths clinic.	27	33	16	1	0	38	25	14	0	0
5	I think the maths clinic really gives benefits to the students in terms of increasing their mathematical skills.	44	23	10	0	0	47	21	9	0	0
6	I think the support and guidance received from the maths clinic is helping me to pass mathematical related subjects.	27	26	24	0	0	36	25	16	0	0

Table 4. Descriptive Measures on Students' Competency Before and After Implementing Maths Clinic

Statement No.	N	Pre-test		Post-test	
		Mean	Std. Deviation	Mean	Std. Deviation
Statement 4	77	4.25	0.728	4.31	0.765
Statement 5	77	4.38	0.744	4.49	0.700
Statement 6	77	4.08	0.807	4.26	0.785

6.3. Improving students' academic performance

A paired sample t-test was employed to compare whether mathematics clinic help students' academic performance. The results were obtained in the following Table 5. There is a significant difference in the mean between the before and after 12 weeks of mathematics clinic conducted. Since $p = 0.022 < 0.05$, the null hypothesis was then rejected.

Table 5. Inferential Statistics between Findings of Pre-test and Post-test Survey

		Paired Differences					t	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference			
					Lower	Upper		
Pair 1	Statement6Pre - Statement6Post	-0.182	0.683	0.078	-0.337	-0.027	-2.336	0.022

Based on Figure 3, there is an increment to the number of students getting A and A+ (Point: 4.00). As compared to semester November 2020, total students obtained these grades are 16 while it is increased to 18 students in Semester April 2021. The equivalent percentage of 12.5% shows improvement in students' academic performance. Moreover, the pattern of increased and decreased in the number of

students getting other grades can be seen in Figure 2 and Figure 3. Overall, this study strengthens the finding that students who attended mathematics clinics passed the subject. On the other hand, students who failed in the course also failed to attend mathematics clinic. By attending a series of mathematics clinic, students are not only able to improve academic performance, but are also able to build confidence and computational skills for their long-term benefits.

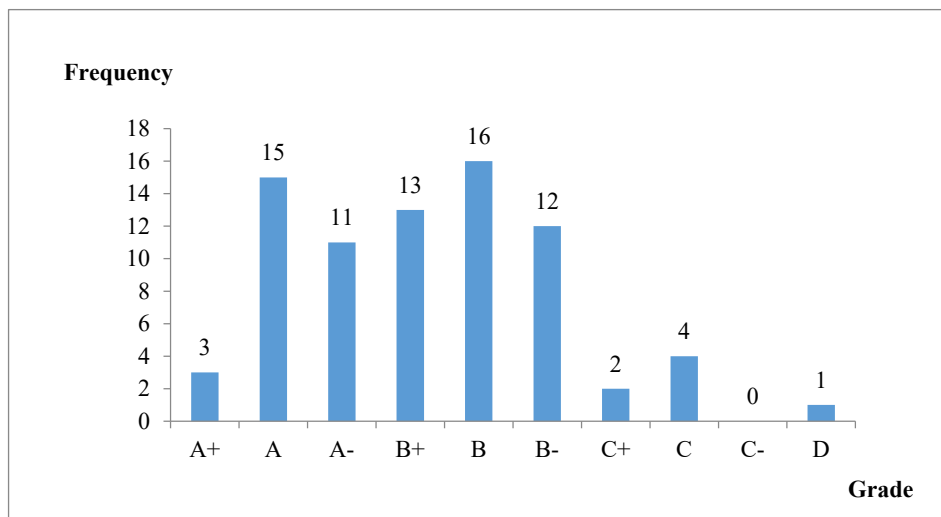


Figure 3. Grades obtained for the mathematical course taken in semester April 2021

7. Conclusion

This study showed that despite all the challenges that have been faced during Covid-19 pandemic, the learning process can still be conducted through an online medium. Even though the sample size of this study is very small, however, the results are encouraging as it showed a significant improvement to the competency of the students in Mathematics after they attend the online clinics. In terms of sustainability of higher education, these online clinics can be used to complement the online classes in order to improve the results of the students who faced difficulties in the studies. On the other hand, it is important to understand that there are some limitations on this study. Other than the small size of respondents, the results of this study also do not include the students who have failed in this subject as they did not participate in the pre- and post-survey online survey. In order to improve the outcome of future studies, these limitations need to be addressed.

References

- Adedoyin, O. B., & Soykan, E. (2020). Covid-19 pandemic and online learning: the challenges and opportunities. *Interactive learning environments*, 1-13. <https://doi.org/10.1080/10494820.2020.1813180>
- Alcock, J., Cockcroft, S., & Finn, F. (2008). Quantifying the advantage of secondary mathematics study for accounting and finance undergraduates. *Accounting & Finance*, 48(5), 697-718. <https://doi.org/10.1111/j.1467-629X.2008.00261.x>
- Asshaari, I., Tawil, N. M., Othman, H., Ismail, N. A., Nopiah, Z. M., & Zaharim, A. (2012). The importance of mathematical pre-university in first year engineering students. *Procedia-Social and Behavioral Sciences*, 60, 372-377. <https://doi.org/10.1016/j.sbspro.2012.09.393>

- Eddie, M. M., & Jose, M. M. (2020). Prospective teacher's online learning mathematics activities in the age of COVID-19: A cluster analysis approach. *Eurasia Journal of Mathematics, Science and Technology Education*, 16(9), em1872. <https://doi.org/10.29333/ejmste/8345>
- Irfan, M., Betty, K., Yuyun, Y., & Sri Adi, W. (2020) Challenges during the pandemic : Use of e-learning in mathematics learning in higher education. *Infinity Journal*, 9(2), 147. <https://doi.org/10.22460/infinity.v9i2.p147-158>
- Ismail, Z. (2018). Benefits of STEM Education. K4D Helpdesk Report. *International Development Department*. https://assets.publishing.service.gov.uk/media/5c6c0ec740f0b647abb525a7/418_Benefits_of_STE_M_Education.pdf
- Johnson, P., & O'Keeffe, L. (2016). The effect of a pre-university mathematics bridging course on adult learners' self-efficacy and retention rates in STEM subjects. *Irish Educational Studies*, 35(3), 233-248. <https://doi.org/10.1080/03323315.2016.1192481>
- Muthuprasad, T., Aiswarya, S., Aditya, K. S., & Jha, G. K. (2021). Students' perception and preference for online education in India during COVID-19 pandemic. *Social Sciences & Humanities Open*, 3(1), 100101. <https://doi.org/10.1016/j.ssaho.2020.100101>
- Nawawi, N. M., Sout, N. M., Hassan, K.B., Samah, N. N. A., Kamaruddin, H. H., Khalid, R. M., & Azman, H. H. (2021). *Journal of Physics: Conference Series*, 1882, 012155. <https://doi.org/10.1088/1742-6596/1882/1/012155>
- Rahman, O., & Johar, R. (2021). Improving high school students' critical thinking ability in linear programming through problem based learning assisted by GeoGebra. In *Journal of Physics: Conference Series*, 1882(1), 012070. IOP Publishing. <https://doi.org/10.1088/1742-6596/1882/1/012070>
- Reddy, M., & Panacharoensawad, B. (2017). Students Problem-Solving Difficulties and Implications in Physics: An Empirical Study on Influencing Factors. *Journal of Education and Practice*, 8(14), 59-62. <https://files.eric.ed.gov/fulltext/EJ1143924.pdf>
- Santiago-Carrillo, M. C., Vergel-Ortega, M., & Parra-López, H. M. (2019, November). Impacts of the mathematical clinic in the academic performance of the students. In *Journal of Physics: Conference Series*, 1408(1), 012016. IOP Publishing. <http://doi.org/10.1088/1742-6596/1408/1/012016>
- Settelmaier, E., & Zadnik, M. (2010, September). Supporting Student Learning and Retention in Physics, Chemistry, Mathematics and Computing—An Evaluation of Curtin University's Science Clinics Program. In *Proceedings of The Australian Conference on Science and Mathematics Education* (Vol. 16). <https://openjournals.library.usyd.edu.au/index.php/IISME/article/view/4697/5462>
- Spitzer, M. W. H., & Musslick, S. (2021). Academic performance of K-12 students in an online-learning environment for mathematics increased during the shutdown of schools in wake of the COVID-19 pandemic. *Plos one*, 16(8), e0255629. <https://doi.org/10.1371/journal.pone.0255629>
- Wong, S. L., & Wong, S. L. (2019). Relationship between interest and mathematics performance in a technology-enhanced learning context in Malaysia. *Research and Practice in Technology Enhanced Learning*, 14(21), 1-13. <https://doi.org/10.1186/s41039-019-0114-3>
- Yeh, C. Y., Cheng, H. N., Chen, Z. H., Liao, C. C., & Chan, T. W. (2019). Enhancing achievement and interest in mathematics learning through Math-Island. *Research and Practice in Technology Enhanced Learning*, 14(5), 1-19. <https://doi.org/10.1186/s41039-019-0100-9>