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Research Article

Examining Students' Learning Self-Efficacy, Mathematics Self-Concept, and Learning Motivation when Learning Mathematics virtually

Theresa Chiew Gim Ean[1], Loh Kah Heng[1], Lim You Ping[1]

[1]School of Liberal Arts and Sciences, Faculty of Social Science and Leisure Management, Taylor's University, Malaysia

Correspondence Author: Theresa Chiew Gim Ean, School of Liberal Arts and Sciences, Faculty of Social Science and Leisure Management, Taylor's University, Malaysia
E-mail: Theresa.Chiew@taylors.edu.my

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Abstract

This study aims to examine the learning motivation of university learners when learning mathematics modules virtually at the Taylor's American Degree Transfer Program in Malaysia. It also aims to examine the connection between their mathematics self-concept and learning self-efficacy using related constructs that are associated with learning motivation, such as intrinsic and extrinsic goals, perceived control, task value, social engagement, support, and self-concept. This study also seeks to investigate learners' preferred learning environment when learning mathematics and what factors informed their preference. A survey was put out using validated and reliable questionnaires obtained from the Revised Study Process Questionnaire (R-SPQ-2F), the Student Engagement (SE) questionnaire, and the Motivated Strategies to Learning Questionnaire (MSLQ) in this study. Due to the switch from traditional face-to-face instructions to virtual learning brought on by the COVID-19 pandemic in the academic years 2020 and 2021, it became important to study how the different profiles of learners with their unique learning behaviors could inform this study and to further investigate the learners' perceptions of the changes and how they were affected in this somewhat unfamiliar learning environment. The questionnaire was returned by 120 students in four mathematics modules taught virtually. The results indicate that: 1) students can be divided into three groups of approaches to learning mathematics: deep, intermediate, and surface; 2) students employ different mental activities when learning mathematics; 3) although students maintain a high level of intrinsic motivation, their self-confidence, cognitive learning strategies, and self-regulation can be improved when in a virtual mode of learning; 4) students with higher learning self-efficacy and self-concept feel less threatened when receiving their instructions virtually and are more confident in achieving good grades. Findings are discussed, and opportunities for further research and development are also suggested.

Keywords: ***Learning Self-Efficacy, Mathematics Self-Concept, Motivation, virtual Learning Environment, Teaching and Learning Strategies***

INTRODUCTION

Studying virtually and classes being delivered in an online or hybrid mode have become prominent features in the new platform of internet. However, the shift in the instructional methodology and its effects on university learners' learning motivation and engagement is not well studied. Factors that are proven to do well in motivating students in the physical classroom setting might not be as effective compared to virtual learning. Hence, over the past decades, researchers and educators were occupied in studying factors that trigger a students' learning motivation. Hattie [15], Hattie [16], and Fullan [24] studied on how students stay positively engaged in their learning and when learning independently, how they continue to remain motivated when faced with challenging situations. Research by Bandura [3] and Schunk [29] also indicates that learning motivation strongly correlates with academic success. In that, inherently motivated students will spend longer time engaging with a task, and be more persistent when encountering

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a problem in their studies, and thus achieving higher grades when compared to their peers who are less motivated. However, much of the research done on the above, was mostly conducted in the traditional face-to-face learning environment. Hence, the question we ask is: will the same results be duplicated in a virtual setting? The emergence of the Covid-19 pandemic which forced all educational institutions to revert to learning virtually provided the opportunity promptly to take advantage of the situation to examine how students will fare in a virtual learning environment as well as provided instructors with an opportunity to re-design their modules to optimize student's learning outcomes, their achievements (grades) as well as their learning motivation.

Even as the pandemic subsides, the growing popularity of MOOCs in higher education cannot be denied. Virtual learning and MOOCs have the advantage of being accessible and flexible, made possible by the increased use of the internet in our daily lives. According to Hussin[18], virtual learning had begun since the late 1990s, in the Malaysian higher learning institutions and starting from year 2019, an estimated 50 percent of all primary and secondary school education were expected to be ready to deliver their teaching and learning virtually, as pointed out by Horn [17]. With this educational developments, the Malaysian Ministry of Education (as presented in the Malaysian Education Blueprint 2015 – 2025) [22] has introduced several innovative plans to encourage and to make virtual learning a fundamental module for higher education as well as for lifelong learning (Higher Education: E-16).

Despite their growing influence and the preference for virtual learning, researchers have found that online modules produce inferior learning outcomes compared to modules offered via traditional face-to-face instruction, as pointed out by Xu [10]. Figlio [9] found that, whether learning was done virtually or in the traditional classroom setting, there is very little difference in the achievement of high-performing students but for poor performing students in the traditional setting, these students perform even more poorly in virtual learning. There is also evidence that students are more motivated when learning in the traditional physical setting than when learning virtually. Moreover, research also found that students might prefer face-to-face instructions for certain modules and digital instructions for other modules. Xu [11] found that students in higher education institutions feel confident taking digital instructions for modules that they perceive as 'easy', but for modules that they deem 'difficult', the traditional classroom instructions is preferred. Hence, the challenges that students faced in learning mathematics virtually could differ when compared with other modules. Most of us are familiar with the term 'mathematics self-concept' which as suggested by Lee [21] and also mentioned by Pajares [25] and Reyes [28] is "how sure a person is of being able to learn new topics and to perform well in mathematics". Thus, when it comes to teaching and learning mathematics virtually, it is important to first understand the relationship between a student's learning self-efficacy and learning motivation and the connection with the mathematics self-concept of the student. Understanding this relationship before the implementation of virtual learning in any modules could help mathematics educators in preparing their teaching plans and learning outcomes in order to achieve positive results for all their students.

According to Bong [7] and cited in Arens [1], learning self-efficacy and self-concept, in general, describes a student's competence. Both share distinctive characteristics, but there are some notable differences. While both predict learning motivation and performance in varying degrees; learning self-efficacy is a person's self-perceived confidence when completing a general task successfully as suggested by Bandura[2] and Zimmerman[31]; whereas according to Marsh[23], self-concept is a person's self-perceived competence when completing the task in an academic setting (in this case: mathematics). Hence, whilst learning self-efficacy is specific to the task, self-concept is specific to the domain of interest as pointed out by Arens[1].

Clinical research has shown that in feared situations (in this case – learning mathematics virtually) people judge learning efficacy low and will not persist at tasks, suggested Bandura[3]. At the beginning of their learning activities, with motivation from their teachers, most students do persist at their given task. But when a challenging or difficult problem surfaces, learning efficacy becomes a poor predictor of motivation and performance in a learning environment. In this case, a student's learning self-efficacy and mathematics self-concept might relate differently to learning motivation and performance. Learning self-efficacy might relate negatively, rather than positively, because higher self-concept would mean that a student does not have to persist as long to answer or solve mathematical problems.

In face of Covid-19 Pandemic, Baticulon [4], Bringula [6], Gledhill [13], and Pena-Bandalaria[26] all echoed that most studies had not had the opportunity nor the need to include the psychological and physical challenges that students might face. Here in Malaysia, where the digital divide is apparent, some important factors need to also be considered such as limited learning space, inadequate access to devices, and Internet infrastructures. Thus, it can be summarized that the profile of the students might well influence their mathematics self-concept. Understanding the

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profile of students and how the above mentioned barriers to virtual learning affects their mathematics self-concept, can assist educational institutions as well as all stakeholders to formulate their teaching and learning strategies to achieve positive online mathematics education.

2. LITERATURE REVIEW

A review of recent research related to virtual mathematics education and its barriers, including academic self-concept, learning self-efficacy, and mathematics self-concept leads to the following summation. Studies on virtual mathematics education is not lacking. What is missing is in-depth studies to include also, the relationship between the students' profile and their mathematics online self-concept. The recommendations set forth for teaching and learning strategies with the emergence of Covid-19 Pandemic can well be extended to achieve the desired mathematics online learning.

Many different studies cited the factors that will influence the students' achievement (grades) when learning mathematics virtually. Wadsworth[30] mentioned that students' learning self-efficacy and the way they learn such as their concentration when studying, how they process information, and how they challenge themselves by self-testing as well as their motivation predicted their online mathematics grade achievement. Glass[12] suggested that students find having adequate exercises and assignments most important for achieving good grades. Bringula[6] wrote that to have a successful virtual mathematics education, regular practices followed by immediate feedback is necessary. In comparing the mathematics achievements and learning self-efficacy of students, Guzeller [14] found significant difference in students learning mathematics virtually and learning mathematics via the traditional face-to-face instructions, with the face-to-face instructions having a more favorable results. Last but not least, in a study by Joo[19], learning motivation, self-efficacy, and cognitive processes were all found to influence online mathematics achievements positively.

While students have experienced some form of virtual mathematics learning before the Covid-19 Pandemic, they are not fully prepared nor equipped in a 100% virtual learning setup. A study done by Bringula[6], reported that the shift in this educational setting has had a negative impact on the mathematics self-concept of students; where more than 80% of respondents in the study said they will achieve lower grade in mathematics. Some of the negative experiences cited were their having difficulty in understanding lessons and solving problems, which led to disinterest and tardiness in attending classes and paying attention. However, the same study also cited some positive experiences from their participants, indicating positive notions such as having interest in learning, doing and helping classmates in the assignments and confident in achieving good grades (positive mathematics self-concept).

2.1 Problem Statement

Prior to COVID-19 pandemic, the Taylor's American Degree Transfer Program (ADTP) has adopted traditional physical teaching and learning. The correlation among antecedent variables such as learning self-efficacy, learners' learning motivation and mathematics self-concept and their mathematics achievement were consistent with most of the research outcome done by other researchers outside and within ADTP. However, the abrupt transformation in teaching and learning, brought upon by the lockdown, warrants a research on the correlation among all the antecedent variables in a virtual learning environment, particularly on a highly logical reasoning subject which many perceived as difficult – i.e. Mathematics.

Hence this research aims to examine learners' learning self-efficacy, mathematics self-concept and their learning motivation when learning mathematics in a fully virtual environment in Taylor's American Degree Transfer Program in Malaysia, which in turn can help inform this new learning setup in a Malaysian context.

2.2 Research Framework, Research Questions, Hypotheses

The research model for this study is proposed as in Figure 1 below. This study addresses the correlation among antecedent variables such as learning self-efficacy, student's motivation and mathematics self-concept and the student Mathematics achievement as well as to determine whether students' learning mode preference has an impact on their Mathematics Achievement.

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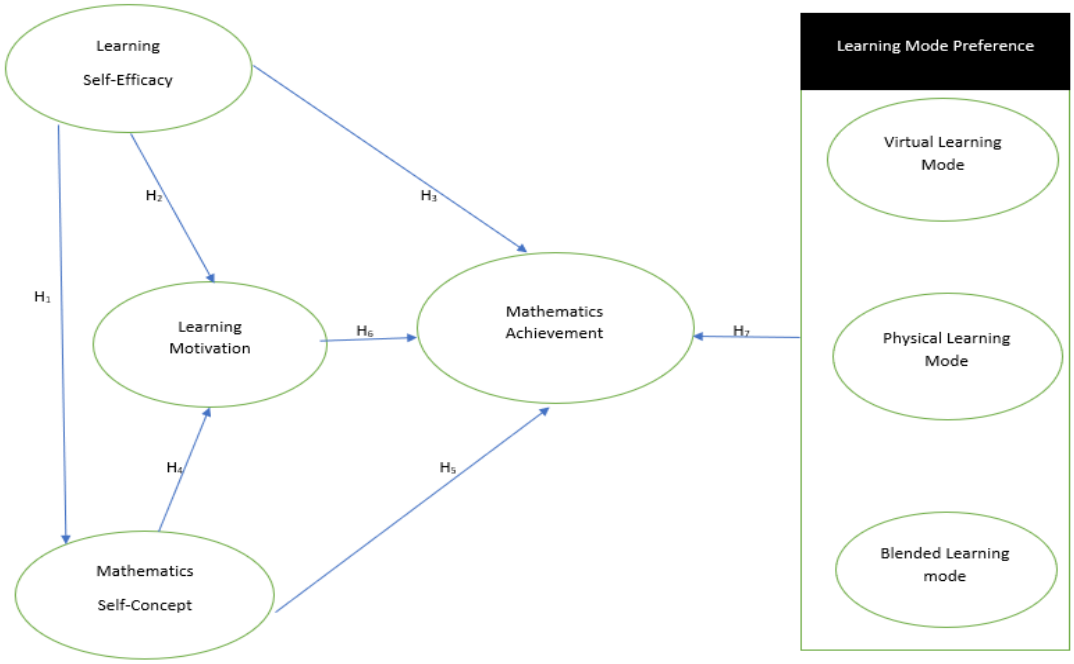

Figure 1: Research Framework exploring relationships between students' learning self-efficacy, mathematics self-concept, learning motivation and grades

The research questions formulated in this study is to determine if there are significant relationships between learners' learning self-efficacy, their mathematics self-concept as well as their learning motivation and grades:

1. Does learners' learning self-efficacy predict their mathematics achievement (learning motivation and grades) in a virtual learning environment and to what extent?

2. Does learners' mathematics self-concept predict their mathematics achievement (learning motivation and grades) in a virtual learning environment and to what extent?

3. Is there a relationship between learners' learning self-efficacy and their mathematics self-concept in a virtual learning environment and to what extent?

4. Does learners' mathematics achievement (grades) predict their preference in learning mathematics mode (face-to-face instruction vs virtual)?

Following from the research questions, the null hypotheses that inform the study are as follows:

H_{01}: There is no significant relationship between learners' learning self-efficacy and their mathematics self-concept when learning in a virtual learning environment.

H_{02}: There is no significant relationship between learners' learning self-efficacy and their learning motivation when learning in a virtual learning environment.

H_{03}: There is no significant relationship between learners' learning self-efficacy and their mathematics achievement (grades) when learning in a virtual learning environment.

H_{04}: There is no significant relationship between learners' mathematics self-concept and their learning motivation when learning in a virtual learning environment.

H_{05}: There is no significant relationship between learners' mathematics self-concept and their mathematics achievement (grades) when learning in a virtual learning environment.

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H_{06}: There is no significant relationship between learners' learning motivation and their mathematics achievement (grades) when learning in a virtual learning environment.

H_{07}: There is no significant difference among learners' learning mode preference and their mathematics achievement (grades).

3. METHODOLOGY

This study was sampled from 120 students in 4 mathematics modules taught fully online in the January semester of 2021. These students were studying at the Taylor's American Degree Transfer Program and the mathematics modules studied were first- and second-year student level, fourteen-week course which meets 3 – 5 hours a week. The study was conducted on students who were in the program before the lockdown due to the Covid-19 Pandemic, where they had experienced face-to-face traditional instructions and thereafter were learning their classes fully online for 1 – 2 semesters, prior to the January semester when this study was done. The survey was distributed digitally and returned by 120 students with the following demographics. 70% of the participants were male and 30% were female students with an average age of 19 years old. 84.2% were Malaysians while the rest were international students from 5 different countries (Korea, Bangladesh, India, Pakistan, Uzbekistan). Over 90% of the respondents were STEM majors.

3.1 Research Instrument

The survey form consisted of 3 parts. The first part gathered information about the student's attitude towards studying and their style of studying in relation to their current mathematics module. The questions were intended to determine the student's learning self-efficacy and their learning motivation with related constructs such as intrinsic and extrinsic goals, perceived control, task value, social engagement, support, and self-concept. The second part questions were directed in order to understand how they think and feel about their mathematics modules. The questions were intended to examine the student's mathematics self-concept with constructs that were deemed relevant pertaining to their Mathematics Achievement Emotions (anxiety, anger, shame, helplessness, boredom). Lastly, the third part questions were directed in order to study their views and preferences in learning mathematics interactively in a virtual environment or via the physical learning mode. All the questions were measured using a 5-point scale with the most negative response having an assigned value of 1 and the most positive response was assigned value of 5 (Disagree Entirely, Disagree for the most part, Neutral, Agree for the most part, Agree Entirely). Negative-worded items were recoded so that they can be combined with positive-worded items before any statistical tests was carried out.

The items of the research instrument were all retained as the questions were all validated and adapted from the Revised Study Process Questionnaire (R-SPQ-2F)[5], the Student Engagement (SE) questionnaire and the Motivated Strategies to Learning Questionnaire (MSLQ)[27]. Reliability coefficients between 0.82 – 0.95 were achieved for all constructs, well above the recommended level of 0.70, indicating that the dependent measures were valid.

4. DATA ANALYSIS AND FINDINGS

The data obtained from the online survey and tabulated in the Google Sheets were converted into CSV format. The Statistical Package for the Social Sciences (IBM SPSS, version 25) was used to analyze this data.

As for the data analysis process, the null hypotheses were tested to either reject the null hypotheses in favor of the alternative hypotheses or fail to reject the null hypotheses.

Table 1 presents the descriptive statistics for the four variables in this study (Learning Motivation, Learning Self-Efficacy, Mathematics Self-Concept, and Grades).

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Table 1: Descriptive Statistics for Learning Motivation, Learning Self-Efficacy, Mathematics Self-Concept, and Mathematics Achievement (Grades).

	N	Minimum	Maximum	Mean	Std. Deviation
motivation	120	2.92	5.00	3.9937	.46104
academic self efficacy	120	2.42	4.96	3.8064	.49552
mathematics self concept	120	2.29	5.00	3.5230	.58644
Grades1	120	1.00	5.00	4.2750	1.09975
Valid N (listwise)	120				

4.1 Testing of Null Hypothesis 1

H_{01}: There is no significant relationship between learners' learning self-efficacy and their mathematics self-concept when learning in a virtual learning environment. The results of the Pearson product-moment correlation are presented in Table 2. This was computed to assess correlation between the two dependent variables, namely learners' learning self-efficacy and their mathematics self-concept when learning virtually. Results indicated that null hypothesis H_{01} was rejected and that there is a strong positive correlation between learning self-efficacy and mathematics self-concept (r(118)=.70, p=.000, two-tailed).

Table 2: Results of Pearson's Correlation Coefficient in testing H_{01}

Correlations

		academic self efficacy	mathematics self concept
academic self efficacy	Pearson Correlation	1	.704**
	Sig. (2-tailed)		.000
	N	120	120
mathematics self concept	Pearson Correlation	.704**	1
	Sig. (2-tailed)	.000	
	N	120	120

**. Correlation is significant at the 0.01 level (2-tailed).

4.2 Testing of Null Hypothesis 2

H_{02}: There is no significant relationship between learners' learning self-efficacy and their learning motivation when learning in a virtual learning environment. The results of the Pearson product-moment correlation are presented in Table 3. This was computed to assess correlation between the two dependent variables, namely learners' learning self-efficacy and their learning motivation when learning virtually. Results indicated that null hypothesis H_{02} was rejected and that there is a strong positive correlation between learning self-efficacy and learning motivation (r(118)=.70, p=.000, two-tailed).

Table 3: Results of Pearson's Correlation Coefficient in testing H_{02}

Correlations

		academic self efficacy	motivation
academic self efficacy	Pearson Correlation	1	.701**
	Sig. (2-tailed)		.000
	N	120	120
motivation	Pearson Correlation	.701**	1
	Sig. (2-tailed)	.000	
	N	120	120

**. Correlation is significant at the 0.01 level (2-tailed).

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4.3 Testing of Null Hypothesis 3

H_{03}: There is no significant relationship between learners' learning self-efficacy and their mathematics achievement (grades) when learning in a virtual learning environment.

The results of the Pearson product-moment correlation are presented in Table 4. This was computed to assess correlation among the two dependent variables, namely learners' learning self-efficacy and their mathematics achievement when learning in a fully online learning environment. Results indicated that null hypothesis H_{03} was rejected and that there is a moderate positive correlation between learning self-efficacy and mathematics achievement ($r(118)=0.45$, $p=0.00$, two-tailed).

Table 4: Results of Pearson's Correlation Coefficient in testing H_{03}

Correlations

		academic self efficacy	Grades1
academic self efficacy	Pearson Correlation	1	.448**
	Sig. (2-tailed)		.000
	N	120	120
Grades1	Pearson Correlation	.448**	1
	Sig. (2-tailed)	.000	
	N	120	120

**. Correlation is significant at the 0.01 level (2-tailed).

4.4 Testing of Null Hypothesis 4

H_{04}: There is no significant relationship between learners' mathematics self-concept and their learning motivation when learning in a virtual learning environment.

The results of the Pearson product-moment correlation are presented in Table 5. This was computed to assess correlation among the two dependent variables, namely learners' mathematics self-concept and their learning motivation when learning in a virtual learning environment. Results indicated that null hypothesis H_{04} was rejected and that there is a moderate positive correlation between mathematics self-concept and learning motivation ($r(118)=0.46$, $p=0.00$, two-tailed).

Table 5: Results of Pearson's Correlation Coefficient in testing H_{04}

Correlations

		mathematics self concept	motivation
mathematics self concept	Pearson Correlation	1	.462**
	Sig. (2-tailed)		.000
	N	120	120
motivation	Pearson Correlation	.462**	1
	Sig. (2-tailed)	.000	
	N	120	120

**. Correlation is significant at the 0.01 level (2-tailed).

4.5 Testing of Null Hypothesis 5

H_{05}: There is no significant relationship between learners' mathematics self-concept and their mathematics achievement (grades) when learning in a virtual learning environment.

The results of the Pearson product-moment correlation are presented in Table 6. This was computed to assess correlation among the two dependent variables, namely learners' mathematics self-concept and their mathematics

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achievement when learning in a virtual environment. Results indicated that null hypothesis H_{05} was rejected and that there is a moderate positive correlation between mathematics self-concept and mathematics achievement (r(118)=0.47, p=0.00, two-tailed).

Table 6: Results of Pearson's Correlation Coefficient in testing H_{05}

Correlations

		mathematics self concept	Grades1
mathematics self concept	Pearson Correlation	1	.474**
	Sig. (2-tailed)		.000
	N	120	120
Grades1	Pearson Correlation	.474**	1
	Sig. (2-tailed)	.000	
	N	120	120

**. Correlation is significant at the 0.01 level (2-tailed).

4.6 Testing of Null Hypothesis 6

H_{06}: There is no significant relationship between learners' Learning Motivation and their mathematics achievement (grades) when learning in a virtual learning environment.

The results of the Pearson product-moment correlation are presented in Table 7. This was computed to assess correlation among the two dependent variables, namely learners' learning motivation and their mathematics achievement when learning in virtual learning environment. Results indicated that null hypothesis H_{06} was rejected and that there is a weak positive correlation between learning motivation and mathematics achievement (r(118)=0.26, p=0.00, two-tailed).

Table 7: Results of Pearson's Correlation Coefficient in testing H_{06}

Correlations

		motivation	Grades1
motivation	Pearson Correlation	1	.260**
	Sig. (2-tailed)		.004
	N	120	120
Grades1	Pearson Correlation	.260**	1
	Sig. (2-tailed)	.004	
	N	120	120

**. Correlation is significant at the 0.01 level (2-tailed).

4.7 Testing of Null Hypothesis 7

H_{07}: There is no significant difference among learners' learning mode preference and their mathematics achievement (grades).

To compare learners' preferred learning mode (virtual, face-to-face, Blended) and their mathematics achievement, a one-way ANOVA was performed and the results shown in Table 8. The results indicate no significant difference, (F(2, 117) = 0.464, p=0.630). Post Hoc comparison tests using Tukey's HSD test revealed no significant difference between preference for virtual mode (M=4.13; SD=1.46) and face-to-face learning mode (M=4.16; SD=1.33); between preference for virtual mode (M=4.13; SD=1.46) and blended learning mode (M=4.35; SD=0.93). We, therefore, accept the null hypothesis that students' preferred learning mode have the same effect on their mathematics achievement (grades)

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Table 8: Results of one-way ANOVA and Post Hoc Comparison test for students' mathematics achievement (grades) for different preferred mode of learning in testing H_{07}

Descriptives

Grades1

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
1.00	8	4.1250	1.45774	.51539	2.9063	5.3437	1.00	5.00
2.00	38	4.1579	1.32596	.21510	3.7221	4.5937	1.00	5.00
3.00	74	4.3514	.92799	.10788	4.1364	4.5663	1.00	5.00
Total	120	4.2750	1.09975	.10039	4.0762	4.4738	1.00	5.00

ANOVA

Grades1

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.133	2	.566	.464	.630
Within Groups	142.792	117	1.220		
Total	143.925	119			

Post Hoc Tests

Multiple Comparisons

Dependent Variable: Grades1

Tukey HSD

(I) PreferredMode	(J) PreferredMode	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1.00	2.00	-.03289	.42974	.997	-1.0531	.9873
	3.00	-.22635	.41116	.846	-1.2024	.7497
2.00	1.00	.03289	.42974	.997	-.9873	1.0531
	3.00	-.19346	.22048	.656	-.7168	.3299
3.00	1.00	.22635	.41116	.846	-.7497	1.2024
	2.00	.19346	.22048	.656	-.3299	.7168

5. DISCUSSION

Part of the purpose of this study was an attempt to determine the relationship between learners' learning self-efficacy and their mathematics self-concept with their academic achievement and learning motivation, when learning mathematics in a virtual environment. The quantitative results were consistent with previous research done indicating that learning self-efficacy and mathematics self-concept have a strong correlation with academic success and learning motivation, whether learning virtually or in the traditional face-to-face settings. But results from this study indicated that when learning was done virtually, there is a weak correlation between academic success in mathematics and learning motivation. Learners who are not confident of their mathematics abilities will take little control and responsibility for their learning. This is consistent with findings by Lee[21] that learners who think they are inferior when it comes to their mathematical abilities will tend to end up with lower mathematics grades. The link between learners' academic achievement (grades) and learning motivation, which was found to be significant, positive but weak, highlights the fact that in order to maintain the students' interest and learning motivation when learning mathematics virtually, they need to be actively involved and participative during lessons. Hence, learning institutions and their educators should take necessary measures to carry out stimulating activities during lessons that will encourage and increase students' learning motivation.

The results indicate that: 1) students can be divided into three groups of approach to learning mathematics; deep (they tend to focus on understanding the mathematical concepts), intermediate (they may use some memorization but also engage in some critical thinking when grades will not be affected) and surface (they prefer to memorize formulas rather than trying to understand concepts); hence 2) students employ different mental activities in learning mathematics; 3) though the level of intrinsic motivation in students starts off high, but when in a virtual learning environment, their self-confidence, their cognitive learning strategies and self-discipline can be improved in order to maintain this learning motivation; 4) students with higher learning self-efficacy and self-concept feel less threatened when receiving their digital instructions and are more confident in achieving good grades.

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For discussion, a two-way ANOVA was used to compare means with two layers of independent variables, to summarize the relationship between students' gender and their preferred mode of learning and students' gender and their preferred mode for assessments, to provide further insights into the factors that affect students' achievement (grades).

Table 9: Results of two-way ANOVA in comparing means with two layers of independent variables.

Report

Grades1

Preferences	2. Gender:	Mean	N	Std. Deviation
Online	Female	4.3125	16	1.07819
	Male	4.3810	21	1.02353
	Total	4.3514	37	1.03323
Physical	Female	4.3500	20	.98809
	Male	4.2063	63	1.17992
	Total	4.2410	83	1.13256
Total	Female	4.3333	36	1.01419
	Male	4.2500	84	1.13938
	Total	4.2750	120	1.09975

Report

Grades1

assessments	2. Gender:	Mean	N	Std. Deviation
online	Female	4.1111	27	1.08604
	Male	4.3390	59	1.04403
	Total	4.2674	86	1.05635
physical	Female	5.0000	9	.00000
	Male	4.0400	25	1.33791
	Total	4.2941	34	1.21927
Total	Female	4.3333	36	1.01419
	Male	4.2500	84	1.13938
	Total	4.2750	120	1.09975

Table 9 shows the following observations:

The report shows that when it comes to learning mathematics, more students prefer receiving instructions face-to-face (69%) rather than in a virtual setting (31%). But when it comes to assessments, more students prefer virtual assessments (72%) when compared to face-to-face assessments (28%).

When comparing gender, there were, nearly the same number of female students preferring physical and virtual instructions while more males prefer physical than virtual instructions. As for preferred mode in assessments, both female and male students indicate that they prefer assessments done virtually.

Among those preferring virtual instructions, the difference in average grades between males and females was 0.07. Among those preferring physical instructions, the difference in average grades between males and females was more than 0.1.

Among those preferring virtual assessments, the difference in average grades between males and females was 0.2. Among those preferring physical assessment, the difference in average grades between males and females was 0.96.

The standard deviations are all relatively close when comparing the above.

The research behind this findings and observations from this study confirms that when it comes to learning mathematics, which involves working with physical materials such as graphs and models, learners tend to prefer hands-on learning which promote understanding and retention of mathematical concepts. In addition, learners also

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prefer that they will have the opportunity to get immediate feedback and answers to their problems. This will be more beneficial for learners who are easily distracted and have a fear of mathematics. As to why more male students prefer face-to-face instructions, when compared to their female peers, one study by Joo[19] suggested that gender differences in learning preferences may be due to socialization and cultural factors, where male students had a more positive attitude towards face-to-face instructions, while female students preferred a more collaborative learning environment. Another study by Cho[8] suggested that male students value the social and networking opportunities in face-to-face instructions, while female students value the flexibility and convenience provided by virtual learning.

When it comes to preference for face-to-face or virtual assessments in mathematics, a study by Kay[20] suggested that learners preferred virtual assessments because they were able to use online tools and resources to help them solve problems while another study by Joo[19] found that learners preferred virtual assessments because they found them to be more engaging and interactive, which may help to increase their motivation and interest in mathematics. In this context, it can be concurred that learners are happier with assessments done virtually as they find it overall easier than face-to-face traditional assessments.

6. CONCLUSION

In conclusion, in the context of higher education learning in Malaysia, whilst the physical readiness to conduct teaching & learning virtually is being vigorously put in place; online-related studying tools are made more accessible and the government has implemented several initiatives to address the digital divide, how mentally ready are higher education learning institutions in Malaysia in conducting teaching & learning in a fully virtual learning environment? Both students and educators need to be re-skilled and be given the necessary support to achieve better learning outcomes. Mathematics educators, in particular, need to understand their students' profiles, their learning efficacy, learning motivation and their mathematics self-concept so as to be able to formulate their teaching & learning strategies to achieve a positive outcome in teaching mathematics in a virtual learning environment.

Whilst it may be feasible to run teaching and learning in some modules, at some level of studies, in some major of studies, this might not be a case of one size fits all. Further studies need to be carried out (in the Malaysian education environment) to ascertain as to at what level of studies can a fully virtual education be carried out successfully and confidently and perhaps to have a general guideline for all stakeholders in the education scene to consider when planning their curriculum.

Whilst we look forward to this paradigm shift in teaching and learning, there is much to be studied and researched and there is also the need to convince educators, learners, and parents alike to embrace it when implemented positively.

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