



Impact of Virtual Learning on Foundation Mathematics Students in a Higher Education Institution in the Gulf during the COVID-19 Era

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Abstract: The Corona Virus (Covid 19) pandemic which is currently ravaging the nations of the world has culminated in the adaptation of virtual learning/online teaching methodology, using information and communication technology infrastructure, to enhance and facilitate teaching and learning (T&L) strategies in higher educational (HE) institutions. This study explores the impact and effectiveness of virtual learning (blended learning) employed by a HE institution on the academic goals of Foundation Mathematics students, during this Covid 19 pandemic era. The study confirms that for learners to continuously engage in virtual learning, developing a positive attitude towards virtual learning is very important. By using descriptive statistics and paired t-test analytical tools to analyze the data obtained, the study verified that BBB virtual learning, which is an instruction strategy adopted in this Covid 19 pandemic era, has significantly impacted on students' academic performance in developing academic skills. It is, however, recommended that further training sessions on virtual learning, for faculty and staff, are rolled out focusing primarily on how this T&L methodology can further improve the efficiency and effectiveness in enhancing and developing learners' academic skills.

Keywords: Coronavirus (Covid 19) pandemic, academic skills, virtual learning, Foundation Mathematics

1. INTRODUCTION

The beginning of the year 2020 saw an outbreak of a pandemic named Coronavirus (COVID-19). To combat the spread of the virus, most communities in several countries were placed under lockdown to avoid increase in the number of infections.

COVID 19 pandemic has severely impacted the world in diverse ways. Consequently, all educational institutions including Higher Education (HE) institutions worldwide, were ordered to close down by their Ministries in charge of Education in their respective countries. The Bahrain Polytechnic, one of the HE institutions in the Kingdom of Bahrain followed the directives from the Ministry of Education and closed down to students, indefinitely, on the 26th of February 2020. Attendance to all classes/lessons were suspended, from nurseries right up to colleges and universities, in order to combat the spread of the virus. The cases of infection, however, continued to rise rapidly and as a result, the Ministry could not order the schools to reopen. Teaching and Learning (T&L), however, had to resume

after 2 weeks without the physical presence of students and teachers in the schools and that posed a huge challenge. Educational institutions, therefore, had to adapt to different ways of delivering teaching and learning (blended learning) to the learners by employing IT infrastructure (using computers, laptops, tablets, phones, interactive white boards and WiFi).

Like all other HE institutions in the Kingdom of Bahrain, the Polytechnic had to completely transition from the traditional face-to-face classrooms to virtual learning environments. Classes resumed, therefore, with lecturers and instructors employing the virtual learning environment to provide blended learning (entailing both synchronous and asynchronous) T&L. The Polytechnic along with other HE institutions in the Kingdom was committed to ensuring that T&L continued even during the lockdown such that learners do not miss out in the pursuit of their academic goals. The university therefore, introduced the Big Blue Button (BBB) (an integrated interface on the Polytechnic's Virtual Learning Environment (MOODLE) platform). The functions of the BBB are similar to Microsoft's TEAMS. BBB



enables learners and faculty members to connect online, while the tutor/instructor delivers the lesson virtually. There are various in-built features that enable tutors to see (video) and hear (audio) students and vice versa. Both verbal and written interactions among learners and between learners and faculty were possible during a lesson. BBB was supplemented with Microsoft TEAMS and ZOOM. Prior to starting virtual/blended lessons using BBB, faculty, staff and tutors were taken through crash training programmes on how to use and navigate through BBB.

VIRTUAL LEARNING DEFINED

Virtual learning has been defined as the acquisition of knowledge that can functionally and proficiently take place in the absence of the traditional face to face class (Simonson, Schlosser, & Hanson, 1999; Rice, 2006; Roblyer et al, 2009; Schlosser & Simonson, 2009). In virtual learning, T&L occurs by means of the use of digital devices connected to the internet (Harrell, 2008)

Singh (2011) defined learning as the breaking out of narrow boxes that knowledge is trapped in; and that during the 21st century, teachers' professionalism, reflection and ingenuity are directing learning to very exciting levels for this new generation of learners and their teachers. The virtual learning environments are, therefore, providing opportunities for learners to acquire knowledge in different places without confinement in a building or premises at any given time. The virtual classes provide an opportunity for learners and instructors to congregate online to share T&L experiences using digital resources and technology during the learning process that takes place online (Cavanaugh et al., 2004; Nsiah, & Oti-Boadi, 2015). This opinion has been shared by two groups of authors (Downes, 2009; Fournier & Kop, 2011) who surmised that the virtual learning environments provide tools that are modified to suit learning and education.

In a virtual learning environment, the learner can participate in a live event without travelling to the place where the broadcasting is happening. The learners get to listen to the sessions, participate interactively and answer questions. Unlike the traditional face-to-face classrooms, virtual learning provides a new way for learners and teachers to communicate, interact and assess the contents of each lesson. Nwelin and Wang (2002) were the first to describe the online learning environment as a virtual classroom. Other labels are e-learning, internet learning, virtual learning, tele-learning and web-based learning. Both synchronous and asynchronous teaching take place in the virtual lessons. One of the advantages with virtual learning is that students who did not attend the live sessions could listen to the recorded sessions over again. Similarly, the live virtual classes allowed for

immediate feedback and interaction between the teacher and learners. Other advantages included the emphasis on independent thinking, spreading thinking models and exercising of self-control (Hill & Hannafin, 2001).

Different digital devices are used in the virtual learning environments, which include computers, laptops, tablets, phones, smart televisions and interactive whiteboards. Emails and websites are additional technologies used in the virtual learning environment. These devices and technologies are substitutes for the traditional face-to-face classrooms as well as the physical interactions between learners and the teacher.

THE VIRTUAL LEARNING ENVIRONMENT (VLE)

On the virtual learning platforms, there is live and constructive interaction and dialogue between the teacher and the learner, over the interface. The integrated web-based application interface (BBB) provides the needed resources to deliver effective T&L. The live chat box which is an integral part of the BBB gives learners the opportunity to interact and collaborate with their teachers and peers. It was important to set clear expectations, when using the VLE platform, since the likelihood of learners veering off, is high. From a pedagogical point of view, the VLE enhances and enriches the experiences of learners, since they naturally duplicate the traditional way of T&L instruction, using IT infrastructure via the internet.

By definition (Lokie, 2011), virtual learning occurs by using internet facilities, programmes and connected systems to access, exchange and utilize facts and knowledge in methods, which until lately, were nearly inconceivable. As a consequence, it includes learning obtained by learners through the interplay of content delivered digitally. Some authors (Downes, 2009; Kop, Fournier, & Mak, 2011) believed that VLEs supply tools that are modified to suit learning and education. With the explosion of technological understanding, tertiary education is stimulating the interest of young learners' expectations by creating more awareness in increasing learners' greater participation in information and communication technology. Learners are therefore able to develop lifelong learning skills which would enable them to address the emergence of new subject regulations and greater usage of technology in learning.

The engagement of learning virtually has never been more salient than in the present and should form an important aspect of this generation's approach to acquiring knowledge and participating in social activities Crawford and Kirby (2008). Institutions had to resort to virtual learning because of the circumstances surrounding the spread of coronavirus (COVID 19) pandemic by



blending virtual learning into T&L, since the world is increasingly becoming technologically inclined. This technological trend is referred to by some authors as an e-driven world (Oye, Lahad, Madar & Ab. Rahim, 2012) has created inconceivable alteration in other aspects of life, besides T&L.

PURPOSE OF THE STUDY

The goal of this study is to investigate the effectiveness of the virtual learning environment (such as BBB) that is currently the only means of delivering T&L strategies in institutions including HE institutions, on the academic goals of Foundation Mathematics students in a HE institution. As a result, it is necessary to evaluate learners' perceptions towards the virtual learning environment which they are currently exposed to, over the past 18 months, in contrast to the traditional face-to-face classes. This study seeks to provide insight into the different perspectives and identify the benefits that students have acquired through virtual learning.

The research will focus on the following questions:

1. What effects is virtual learning having on T&L from a learner's perspective?
2. To what extent are the learners benefiting from the use of virtual learning in comparison to the traditional face-to-face settings?

RESEARCH METHODOLOGY

The methodologies used in this study adopted mixed methods of collecting and analysing both qualitative and quantitative data. To ascertain the impact of virtual learning (BBB) on learners, appropriate methods of study that could measure the impact of BBB on learners were contrived and executed. Hence data was collected using the two approaches:

The Assessment data: An assessment was administered to learners prior to the teaching of certain Mathematical concepts online, using the BBB. The BBB virtual learning environment was similar in its operation to TEAMS on Microsoft platform. The distinctive features of BBB included virtual face-to-face interactions among learners, and between faculty and learners; instantaneous access to chat boxes by learners and tutor. In addition, learners could be grouped in 'break-out' rooms to complete tasks; learners had access to interactive whiteboards as the tutor taught the lesson; and many other unique features. The only missing factor, in comparison to face-to-face teaching, was the physical presence of learners.

The test was constructed and uploaded on the Polytechnic's MOODLE learning platform with all the

necessary security systems configured. The test was only accessible to students on the scheduled date and time, since the login details were given to students on the date and time of the assessment. Throughout the test, learners were made to have their video cameras (cams) turned on to show their location and their surroundings. Learners also shared their desktops with the invigilators, while answering the questions in the assessments. The progress of students was monitored, onscreen, throughout the duration of the examination, since their video cams remained turned on. They were expected to log off as soon as they completed their assessment. There was immediate feedback as to what grade or marks they obtained as soon as they completed the test before logging off. After the expiration of the assessment time and date, no student could access the test online, nor attempt taking the test the second time. These in-built configurations and security features were in place and left no room for any potential examination malpractices. The assessment therefore, was digitally proctored.

After learners had taken a number of BBB sessions/lessons at which the topics featured in the first assessment that was administered were covered, a second assessment was administered to the learners. This second assessment was similar in contents and level to the first one. All the necessary configurations and measures were put in place to ensure the integrity of the second assessment. Each assessment, 'prior' and 'post' BBB sessions, lasted for 30 min. This was to ensure the integrity of the assessment and to completely eliminate any potential examination malpractices. The topics that were taught covered 3 Mathematics lessons for 6 hours.

Questionnaire: A questionnaire was administered (with some questions based on the Likert model). The questionnaire was administered to 300 sampled students who promptly responded. It was administered to solicit students' feedback and responses based on their experience and/or impression of the BBB virtual learning experiences.

The main objective of this research is to investigate the effect/impact of virtual learning (BBB) on Foundation Mathematics students at a Higher Institution in the Kingdom of Bahrain. The current reality facing all Higher Education institutions, world-wide, is the fact that all T&L is done virtually, and the Bahrain Polytechnic (BP) is no exception, since teaching and learning at the School of Foundation is conducted using the BBB virtual environment platform due to the COVID-19 pandemic. It is important to mention that Mathematics courses at School of Foundation are compulsory/mandatory and students cannot progress to their degree programmes of study unless they successfully complete these Foundation



Mathematics courses. Furthermore, students' grades in these courses are taken into consideration when admitting them to pursue their different degree disciplines at BP, as they are regarded as one of the key factors in predicting the likelihood of learners to the successful completion of their Bachelor's degree qualifications. The outcome, therefore, of this study is significant as it will indicate the effectiveness of the virtual teaching and learning methodology and it will also identify areas of development of this novel teaching & learning in order to benefit and enhance the overall teaching and learning experiences of learners.

Analysis of the data took place in two stages: pre-introduction (*pre-*) of virtual learning and post-introduction (*post-*). This study included a sample of 300 students. The data analysis used for the quantitative data obtained includes Paired t-test to compare *pre-* and *post-* students' assessment data. The other set of data comprises students' feedback/responses to a questionnaire covering their virtual learning experiences. The questionnaire was distributed to the 300 learners who took the *pre-* and *post-* assessments.

RESULTS AND DISCUSSION

Assessment data analysis:

As mentioned in the previous sections, a sample of 300 students (out of 650) was randomly selected from learners who were enrolled in three Mathematics courses at the School of Foundation (100 students from each Mathematics course). They were given a test on a selected topic before attending the virtual learning session on those topics. They were then given another test, similar in contents and scope as the first test, on the same topics after attending the virtual learning sessions which covered those topics.

A. Mathematics 1 course data analysis:

Mathematics 1 is the lowest level Mathematics course at the School of Foundation. At this level, students are revisiting some of the fundamental mathematical concepts, in order to prepare them to undertake the next level Mathematics course (Mathematics 2) before proceeding to their chosen degree programmes of study. Table 1 below gives a summary of a t-test analysis on Mathematics 1 assessment results/grades. It is evident from the t-test analysis that the average results/grades of students after the virtual learning (*post-*) equals to 8.9 out of 10, whereas, it was 6.8 out of 10 prior (*pre-*) to it. The data shows approximately 30% improvement in the overall performance by learners on that topic when comparing the two scenarios. Moreover, by comparing the *pre-* and *post-* virtual learning

variances, *post-* learning had a lower variance suggesting that students' overall performance become closer to the average (less mark outliers). This adds more evidence to the proposition that students' overall performance did improve after their exposure to the BBB virtual learning sessions.

To prove the initial findings mentioned above, paired t-test was performed to test the following hypothesis:

H_0 : There is no difference between the *pre-* and *post-* virtual learning students' performance

H_1 : There is a difference between the *pre-* and *post-* virtual learning students' performance

By referring to Table 1: t-test on Mathematics 1 assessment data, it can be concluded that the null hypothesis is rejected at 95% level of confidence (p value < 0.05). This proves that students performed better after attending the Mathematics 1 virtual learning sessions, and therefore, it is statistically significant that these sessions have proved very effective in enhancing learners' academic achievements.

Table 1. t-Test for Mathematics 1

	Sum of Pre grade	Sum of Post grade
Mean	6.825842697	8.960674157
Variance	10.90398366	3.66604954
Observation	89	89
Hypothesized	0	
Mean Difference		
df	88	
T Stat	-6.107602104	
P(T T<=t) two-tail	2.67796E-08	

B. Mathematics 2 General course data analysis:

This is the next level Mathematics course for the non-technical students at the School of Foundation. In Table 2 below, which shows t-test analysis for Mathematics 2 General assessment data below, it is evident that the average results of students *post-* the virtual learning equals 9.6 out of 10, whereas, it is 8.5 out of 10 prior (*pre-*) to it. Our data obtained therefore indicates around 13% improvement in the overall learners' performance in assessment after the BBB virtual learning sessions. This can be related to the fact that students at this level possess a good knowledge of basic Mathematical concepts. In addition, data shows that participation and attendance at the BBB virtual lessons has significantly improved their knowledge in these basic Mathematical concepts.



To further prove the initial findings mentioned above, a paired t-test was performed on the ‘pre’ and ‘post’ data to test the following hypothesis:

H₀: There is no difference between the *pre*- and *post*- virtual learning students’ performance

H₁: There is a difference between the *pre*- and *post*- virtual learning students’ performance

By referring to Table 2: t-test on Mathematics 2 General assessment data, it is evident that the null hypothesis is rejected at 95% level of confidence (p value < 0.05). This proves that students performed better after attending the Mathematics 2 General virtual learning sessions after the Mathematical concepts were taught. It is, therefore, statistically significant that these virtual learning sessions are effective in developing Mathematical concepts and skills in learners.

Table 2. t-Test for Mathematics 2 General

	<i>Sum of Pre Grade</i>	<i>Sum of Post Grade</i>
Mean	8.456790123	9.62962963
Variance	10.40123457	8.923611111
Observations	81	81
Pearson Correlation	0.288623457	
Hypothesized Mean Difference	0	
df	080	
t Stat	-2.845224918	
P(T<=t) one-tail	0.002817063	
T Critical one-tail	1.664124579	
P(T<=t) two-tail	0.005634126	
t Critical two-tail	1.990063421	

C. Mathematics 2 Technical course data analysis:

This is the next level Mathematics course offered at the Bahrain Polytechnic for the Technical degree major students (who will either pursue IT or Engineering degree programmes) at the School of Foundation. Students at this level are considered to be the best students in Mathematics at the Foundation level. It is evident from Table 3 below, which shows t-test analysis for Mathematics2 Technical assessment data below, that the average results of students *post*- the virtual learning are equal to 8.8 out of 10, whereas, it is 8.2 out of 10 prior (*pre*-) to it. This shows around 7% improvement in the overall learners’ performance under the two defined scenarios. The low percentage can, however, be related to the fact that students at this level possess a good

knowledge in the basic concepts in Mathematics. Learners’ attendance and participation, however, in the virtual lessons tend to improve their knowledge in the basic Mathematics concepts and skills to a very large extent. Moreover, by comparing the *pre*- and *post*- virtual learning variances, it looks like *post*-learning has a comparatively lower variance suggesting that students’ overall performance grades in the assessment tends closer towards the average (less mark outliers).

Furthermore, to verify the initial findings mentioned above, a paired t-test was performed on the assessment data to test the following hypothesis:

H₀: There is no difference between the *pre*- and *post*- virtual learning students’ performance

H₁: There is a difference between the *pre*- and *post*- virtual learning students’ performance

By referring to ‘Table 3: t-test on Mathematics 2 Technical’ assessment data, it is evident that the null hypothesis is not rejected at 95% level of confidence (p value > 0.05). Although there was a slight improvement in students’ overall performance (higher grade average and lower variance), however this improvement appears not to be statistically significant.

Table 3. t-Test for Mathematics 2 Technical

	<i>Sum of Pre Grade</i>	<i>Sum of Post Grade</i>
Mean	8.194444	8.842593
Variance	25.80582	5.356831
Observations	54	54
Pearson Correlation	0.270247	
Hypothesized Mean Difference	0	
df	53	
t Stat	-0.95626	
P(T<=t) one-tail	0.171641	
T Critical one-tail	1.674116	
P(T<=t) two-tail	0.343282	
t Critical two-tail	2.005746	

Data Analysis of Questionnaire:

A questionnaire was constructed based on the outcomes of the quantitative data, since the goal of the researchers was to solicit learners’ impressions about their experience with virtual learning. The questionnaire was constructed by considering learners’ overall impressions about the virtual online learning sessions and their effect on the development of their learning skills.

Some of the key responses from the questionnaire are highlighted with comments in the paragraphs below. Learners were made to respond to the question of whether they were given clear information about how to access BBB, the online virtual learning classroom before they started (Fig 1, below). They were in total agreement (where the low rating scale refers to a stronger agreement), principally because in this current era, 21st century, majority of young people have vast knowledge

in Information Technology (IT) and are highly skilled in IT as well as in the various applications (apps). This assertion is in agreement with one of the main findings in a report published by Anderson and Rainie (2012) about teens, technology and human potential in 2020, in which they stated that ‘millennials will benefit due to their hyper connected lives’. Therefore, acquiring skills and knowledge about how to access an innovative T&L app was not a ‘big deal’ for them.

36% of people rated **Low rating (1-2)** for this question, and the majority answered "**Low rating (1-2)**" for Question 5.

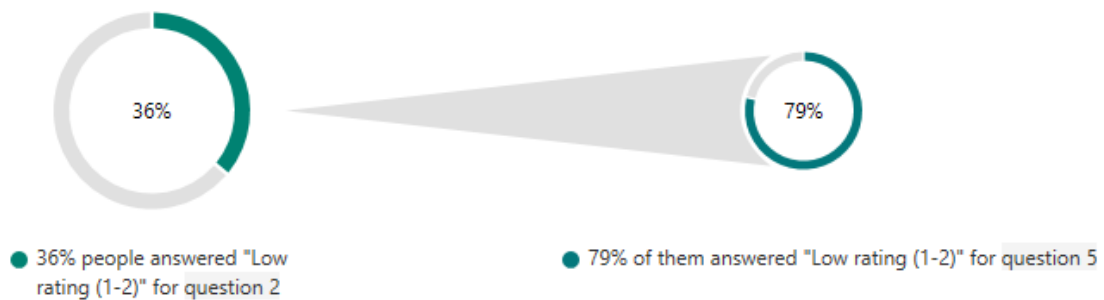


Figure 1. Whether clear information was passed on to learners about how to access the online virtual learning classroom before they started? (Scale: 1-Strongly Agree; and 5-Strongly Disagree)

To find out what type of IT device learners used to access the internet, most learners (more than 80%) indicated that they accessed the virtual learning classes using laptops (Fig. 2), which is the ideal/proven IT device to use because of its in-built features in

comparison to the other devices (such as tablets and phones). Besides, the versatility of the laptop enables learners to readily access virtual classes, even outside the confines of their homes.

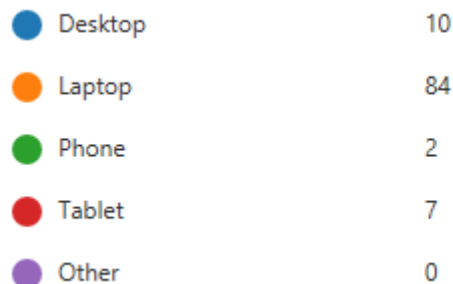


Figure 2. The different types of IT devices that learners used to access the virtual classes.

To ascertain the level of stability of internet connectivity, learners were made to comment on how stable their internet connectivity were, and whether they were devoid of any interruptions. Learners were unanimous in their responses (Fig. 3) that internet connectivity was the most persistent problem confronting them most of the time. This sentiment was expressed by most of the learners and unfortunately, the problem

continues to persist. Internet connectivity is crucial in virtual learning and must be addressed by all the stakeholders (the government authorities, the Ministry of Education, Higher Education Council, Students councils) in order to evolve a lasting solution to this persistent problem militating against virtual learning in Higher Education, especially in the developing world.

32% of people rated **Low rating (1-2)** for this question, and the majority answered "**Low rating (1-2)**" for Question 5.

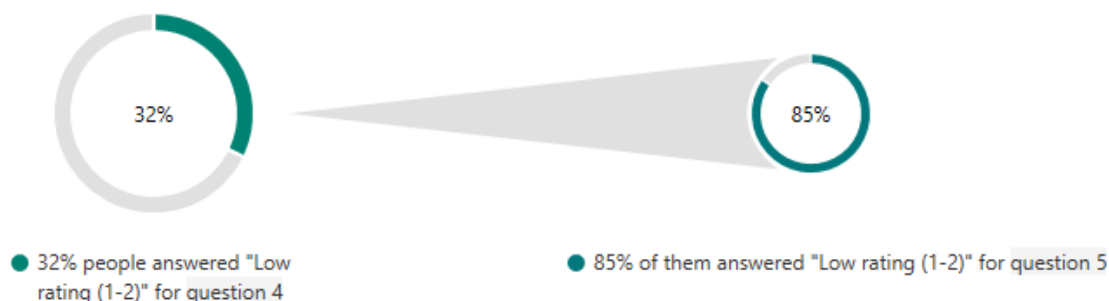


Figure 3. Stability of learners' online connectivity most of the time (with or without interruptions)

Learners' reaction as to whether the Big Blue Button (BBB), which is an integrated virtual learning platform linked with the VLE (MOODLE) of the Polytechnic, was ideal for virtual learning, most of the learners strongly agreed that the virtual learning environment was ideal for online classes and that they indeed enjoyed the virtual/online learning environment/atmosphere during the lessons. On the other hand, with regards to whether they enjoyed the virtual learning environment during lessons, learners agreed, not in stronger terms though, that they enjoyed virtual learning. The reluctance on the part of learners in their response is not surprising, since much as they might enjoy the virtual learning environment, it is obvious that they are still missing out on the face-to-face

social aspect of learning, which cannot be substituted with the virtual classroom.

On the question of easy accessibility to online course materials during virtual lessons, over 75% of learners testified that they found it extremely easy and very easy to access course materials online. Again, this may be attributed to the high-level IT skills and knowledge possessed by learners which enables them to navigate the World Wide Web with ease (Fig. 4).

● Extremely easy	36
● Somewhat easy	41
● Neutral	19
● Somewhat not easy	6
● Extremely not easy	2



Figure 4. How easy it was for learners to access materials during the virtual/online classes?

Learners were asked whether the virtual classes gave them the opportunity to learn at their own pace, a very significant number of learners, 86% of them, indicated that on-line classes offered them a great opportunity to go at their own pace (Fig. 5). A smaller percentage of learners, however, indicated that they were denied that opportunity. This may probably be due to conditions prevailing in their homes (domestic factors) and environmental factors.



Figure 5. Opportunities for learners to study at their own pace

In response to the level of engagement between teachers and learners, 96% agreed that their tutors actively engage them during the virtual/online classes (Fig. 6). To make up for the absence of face-to-face teaching, teachers are compelled to upscale the level of interactions with

learners by engaging them mostly in Q & A sessions, either verbally or written – chat box, during the virtual classes, since that is the only means of involving learners in the T&L process. It is not surprising, therefore, that most learners indicated such in their responses.

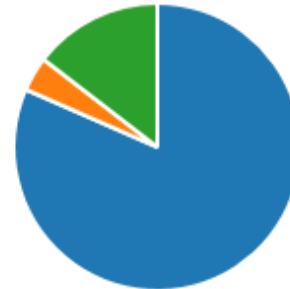


Figure 6. Levels of active engagement among teachers and learners.

One of the key components in virtual learning, and for that matter T&L, is the teacher factor. The question, therefore, of whether learners can readily have access to the teacher just as pertains in face-to-face interactions, is critical. The data obtained from learners clearly indicated 98% of them asserting that their teachers were available to answer their questions during the virtual/online lessons (Fig 7).

This is a very significant response since teachers play a major role in any T&L process. It is interesting to note that the level of active engagement among teachers and learners is similar to the teachers' availability to respond to learners' questions during virtual classes.

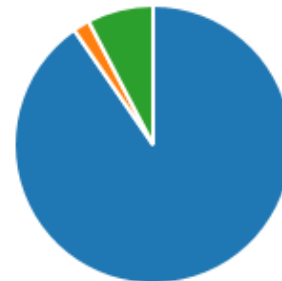


Figure7. Availability of teachers to respond to learners' questions during the virtual learning process

Learners should be able to exhibit how confident they are in their subject knowledge from virtual learning. 80% of learners expressed either extreme or a high level of confidence in their subject knowledge; while a very small percentage of learners expressed lack of

confidence. The distribution of the data in response to this question, however, assumed a normal distribution (Fig. 8). This is an indication of the need to pay attention to the development of confidence among learners.

● Extremely confident	19
● Somewhat confident	38
● Neutral	25
● Somewhat not confident	14
● Extremely not confident	7



Figure 8. Learners' levels of confidence about their subject knowledge after engaging in virtual lessons

In response to whether learners were achieving their learning goals through the virtual learning sessions, 78% responded in the affirmative (Fig 9). This high level of response is very positive, considering the fact that virtual learning is a new learning experience to most learners. It

is not surprising, therefore, that quite a significant number (31%) of learners felt that they were not achieving their goals. This could be linked to the level of confidence learners have expressed about their subject knowledge, which translates into achievement of their academic goals.

● Yes	46
● No	25
● Maybe	32



Figure 9. Whether learners were achieving their learning goals through the virtual classes

Learners needed to show good academic progress since they got engaged in virtual learning sessions. From Fig 10, below, 85% of learners responded in the affirmative, implying that they were deriving the

maximum benefit from virtual learning just as what pertained during face-to-face T&L sessions. The negative response rate of 19% may be attributed to unfavourable domestic and environmental factors, in the case of those learners.

● Yes	53
● No	19
● Maybe	32



Figure 10. Learners showing good academic progress while attending virtual learning classes

One of the key questions the learners responded to related to positive features that they might have discovered from virtual learning classes, since they got engaged in it. Figure 11 below summarised their responses. The most popular response learners indicated was that they felt more relaxed during virtual learning sessions. This may be attributed to the fact that in the absence of their mates, the element of intimidation and

feeling under immense pressure do not exist, since they are 'attending' classes from the comfort of their own home environment. Another overwhelming response is the fact that learners indicated that they were able to learn at their own pace and that were able to ask questions for clarifications as and when necessary, without fear of intimidation.

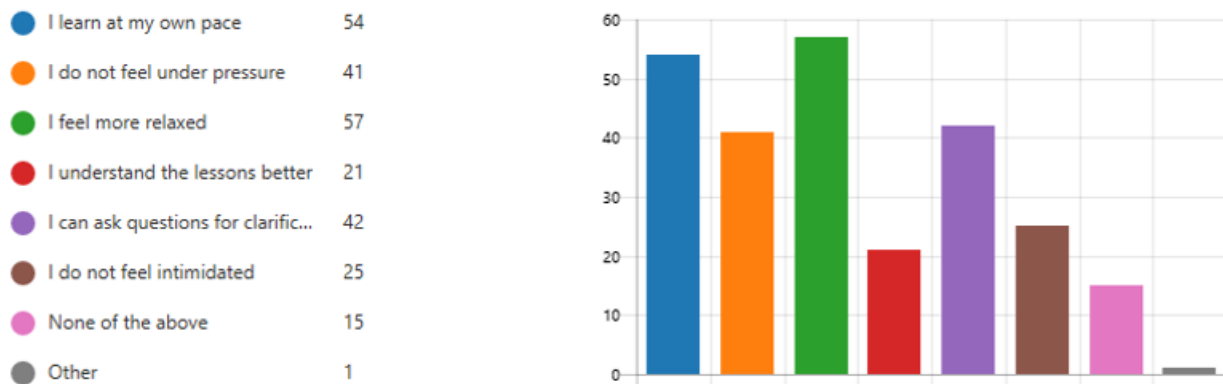


Figure 11. Positive features of virtual learning classes from learners' perspectives

Learners' responses to the kinds of challenges they were facing during their virtual learning experiences (Fig. 12), indicated that the main challenge encountered by most of them in this era was with internet connectivity. This problem can be placed squarely on the Internet Service Providers (ISPs), since it appears to be a universal problem encountered by many learners worldwide, especially during this unusual Covid 19 pandemic era. It is possible that the ISPs have been made aware of this major setback confronting virtual learning worldwide. Hopefully, they are working hard to resolve these challenges facing learners to minimize poor

connectivity for learners. One other main challenge most learners identified and indicated was their inability to interact with their classmates and friends. Again, this has been another challenging circumstance for all learners worldwide; the fact that there is very limited or no interaction among mates, friends and colleagues has been unbearable to most of these young men and women. Furthermore, this lack of interaction is having dire consequences on people, especially the young men and women and borders on mental health, well-being and acquisition of certain skills, like social skills.

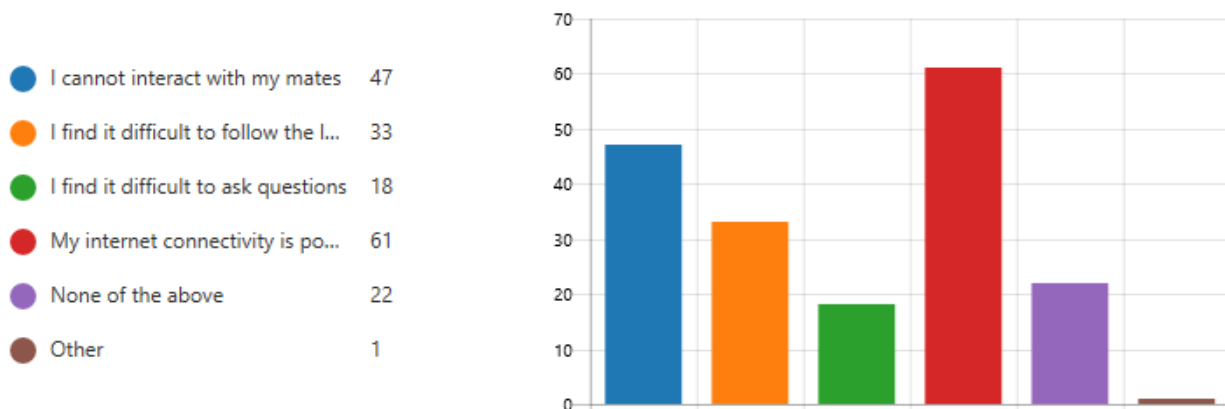


Figure 12. Challenges learners faced during online classes

Despite all the gains and positive feedback from learners about their virtual learning experiences, a very high percentage of learners still indicated that they would prefer to attend in-class face-to-face T&L sessions compared to virtual learning classes (Fig. 13). Interestingly, almost an equal percentage of learners indicated that they would prefer a blend of both virtual

and in-class T&L sessions/classes (referred to as blended-learning). This is a laudable proposal that all the stakeholders (including the Higher Education Council in the Kingdom, administrators, curriculum developers and faculty) may have to consider, moving forward.

● Online	21
● In class	36
● Both	32
● Other	14



Figure 13. Learners' preferences for both virtual/online sessions and in-class (face-to-face) sessions.

In response to whether they would love to take another course in Mathematics virtually (Fig. 14), given the opportunity, approximately 50% of the learners rejected that proposal. Only a very small percentage of learners responded in the affirmative (yes or maybe). This emphatic response is not surprising since the virtual learning experience has not been smooth-sailing for most

learners, especially in the social and psychological contexts. The psychological and social impact on teachers, as well, cannot be under-estimated although no study or data is available yet, which assesses the impact of virtual T&L on teachers and educators.

● Yes	28
● No	46
● Maybe	30



Figure 14. Learners' responses to whether they would be willing to take another online course in Mathematics

CONCLUSIONS

This study outlined reasons why, in this Covid 19 pandemic era, a virtual teaching and learning methodology (BBB) in higher education had utilized the principles of learning in order to offer effective pedagogy. This conclusion corroborates with the assertion made in recent studies (Rapanta et al., 2020; Coman et al., 2020; Ali, 2020). The virtual learning platform, BBB, has been proved to enhance the acquisition of Mathematical skills and concepts, by learners, since it provided short, frequent incidents of practices, such assessments and feedbacks, compared to the less frequent in the case of face-to-face T&L sessions. This finding agreed with a recent study (Khalil, et al, 2020) which reported that the online sessions were time-saving and that learners' performances were improved due to enhanced utility of time.

The results from this study amply demonstrated that virtual learning (including both synchronous and asynchronous T&L sessions), which substituted the traditional face-to-face T&L methodology, in this pandemic era, was capable of enhancing learners' performance, since among other things, it enabled students to access the course materials that were provided, without restrictions and at a time and period convenient for them. Another significant advantage that was offered by this virtual T&L environment was that it had proven to expand learners' memory through administering assessments that were full-proof from cheating and involved deeper levels of thought processing. In addition, virtual learning had proven to encourage critical thinking among learners as well as enhancing their writing skills by means of increasing their writing opportunities (like contributing on the chat boxes and taking notes). This finding was corroborated by a recent meta-analysis study (Means, et al, 2010) which evaluated 50 high quality contrasts of virtual



learning versus face-to-face teaching and learning strategies.

The data obtained in the study portrayed a consistent advantage in student learning in virtual learning environments compared to face-to-face classes. Just like in the meta-analysis study cited, the findings from this study however, cautioned against attributing all the positive effects of virtual learning to the medium of instruction, since it was very likely that any other methodology which capitalized on the fundamental principles of learning could always lead to a more successful pedagogy.

RECOMMENDATIONS

It is recommended that further training sessions on virtual learning for faculty and support staff is necessary to focus primarily on how this currently adopted T&L strategy can help to improve the efficiency and effectiveness in the development of skills that will further enhance learners' academic skills. In addition, a study exploring the effect of social, mental and psychological factors on T&L on both learners and teachers during this COVID 19 pandemic era will be a very useful study since the outcome of such a study will impact the virtual learning T&L practices.

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