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THE EFFECTIVENESS OF ONLINE-BASED LEARNING IN JAVA PROGRAMMING LANGUAGE: STUDENT PERCEPTIONS AND PERFORMANCE

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ABSTRACT

This research aims to explore the effectiveness of learning Java programming language using online-based learning compared to traditional-based learning towards undergraduate students in Universiti Utara Malaysia (UUM). Similar types of learning materials in the form of slides, notes and books are used with additional forms of assessments to substitute the final exam. The main difference is in the learning approaches which have been switched to online based via various platforms depending on the suitability and preference of the students. This research focuses on identifying and analyzing certain aspects from the students' perceptions, which are the students' (1) learning preference; (2) learning engagement; (3) learning assessment, and in terms of their overall (4) satisfaction towards the learning process. This research uses a quantitative approach through the questionnaire as the survey instrument, involving 31 students. The data is analyzed using descriptive statistics (percentage frequency distribution, mean, and standard deviation). Findings show that despite using online-based learning, 48.39% obtained marks above 80% in Lab Test 2, which is doubled compared to the previous test, Lab Test 1, 25.81%. This indicates that while students prefer traditional-based learning, they are able to perform better through online-based learning.

Keywords: online-based learning, e-learning, programming, programming language

INTRODUCTION

Learning programming has long been a challenge for novice programmers as many struggles to assimilate the concepts in the early stages which make it more difficult to grasp and master the advanced concepts that are closely built onto the basics. It is widely accepted that it takes more or less ten years to turn a novice into an expert in programming (Cazzola et al., 2016; Wang et al., 2011). The method of learning programming from face-to-face to online-based learning is not something new as many self-taught programmers learn through the available online resources. However, this is not an easy task. Typically, in higher education institutions (HEIs), programming subject is taught in a traditional face-to-face setting. Converting to a fully online-based is difficult for students who are not familiar with the subject in grasping and their ability to code independently.

Online-based learning has gained momentum in the field of education due to the availability of Internet access from many parts of the world. This is made possible due to the emerging advancements in broadband and computing technologies that enable faster access to many Internet services at affordable fees. Online-based learning is a form of distance learning which typically is targeted to part-time or graduate students. This is because online-based learning supports and simplifies various demands, needs, and backgrounds in terms of the learning spaces, learning context-awareness, intelligent, and adaption learning environments.

Typically, in a normal class environment, students can practice writing, typing, and running their codes while having the lecturer close to guide and help to debug on the spot if necessary. By moving to online-based, it is difficult to provide prompt help when the students need it as (1) students share only one small part of the code which does not have error, (2) students tend to write and run the code at odd hours, and (3) going back and forth tweaking the code can be confusing and time-consuming. This prolongs the process of understanding the concept and ability to code as delaying the feedback would delay the overall learning process.

In addition, studies conducted by Cantabella (2020) and Maltby (2020) found that in online-based learning, there are limited interactions between the students and lecturers. This can be difficult and frustrating for the students in acquiring the programming language knowledge (Yagci, 2017) as there are delays in getting replies to their queries. The study found that on average, it took 3-5 days for the lecturers to respond to the students' online queries which affected the students' overall comprehensiveness of the course content. Typically, in traditional-based learning, students are able to interact directly with the lecturers and other students which allows prompt answers. It was also found that the number of students failing and dropping out of the course is higher in the online environment especially in the advanced programming course (Cantabella, 2020; Chimanga, 2021). Students preferred and felt that traditional lectures have better educational values than online-based as many showed disinterest and lack of motivation in commencing online-based learning because of the social isolation in the virtual lectures. It is difficult to duplicate the traditional, face-to-face classroom environment into the online environment. Apart from these challenges, there are also constraints in terms of technical failures and deficiencies such as inaccessibility to computers and the Internet (Chimanga, 2021; Yagci, 2017).

Moreover, the Covid-19 pandemic has moved education online for most students. Even though online-based learning is part of the fourth industrial revolution (IR 4.0) and has been discussed for a few years, it has not been implemented widely (MoHE, 2018). It requires early preparedness and mitigation plans to ensure a smooth online-based learning transition. The Covid-19 pandemic has pushed HEIs to promptly switch to online-based to minimize and combatting the spread of infection while ensuring continuous learning in this difficult time. Studies from Njenga & Fourie (2010), and Shaw (2012) stated that traditional classes cannot be fully replaced by online-based learning, however, the online platforms can act as a supplementary materials in supporting traditional classes to increase students' performance in learning a programming language. However, due to the Covid-19 pandemic, it is not a choice but rather the only

acceptable option to move from traditional face-to-face to fully online which, with the right platforms, can be considered as virtual face-to-face.

Those who have never experience an online interaction before would find that the sudden transition burdening. It is not as simple as changing the way the class is conducted from traditional face-to-face to virtual face-to-face sessions. It requires well-thought planning to include lectures and assessment activities that are in line with the student learning time to avoid overwhelming the students. The traditional face-to-face programming classes normally run for 2 hours. This needs some well-thought adjustment for the online-based classes to ensure students remain focus and engage within the long learning hours. There have been studies that prove students' attention span starts to decline after the first ten to thirty minutes of a lecture (Bradbury, 2016; Bunce, 2010; Liang et al., 2017; Weinstein, 2018). It is much more difficult to track students' attention during online classes while being hidden behind the device, which lacks constant eye contact, expressions, and body language.

There are many platforms and technology that can be used to facilitate seamless migration to an online-based platform. However, this proves to be a challenge to many academicians and institutions to adopt different remote learning approaches in a limited time to ensure continuity and effective teaching and learning process while minimizing the learning disruption and impact it could have on students. It is crucial to ensure that the quality of the online classes and digital content provided are comparable with normal traditional face-to-face classes. Several issues are expected to occur on both the lecturers and students sides, particularly in terms of the (1) access to reasonable quality Internet bandwidth regardless of the locations, (2) the load increase in the use of digital platforms, and (3) the capability to master and adjustment to the learning paradigm of online-based.

In terms of access to the Internet, there have been many supports and initiatives from many parties to ensure a smooth transition towards online-based learning. The government of Malaysia has offered 1GB worth of Internet data for Malaysians per day (MCMC, 2020) during the Malaysian Government Movement Control Order (MCO) and many telecommunications companies (telcos) offered plans and lowered the cost of Internet for students to show their support towards the national online education effort to enable access to educational materials and online-based learning in addition to Internet providers have widened the Internet connectivity coverage to many parts in the country that were not covered previously and to serve high traffic demands.

The success of online classes depends largely on the use of the right platforms to translate the traditional face-to-face style to the digital environment and the ability of the instructors/educators to utilize the technology in delivering the class. Learning programming has already been deemed to be difficult for some students due to the reasons mentioned previously. Converting the learning process from traditional face-to-face to online-based does not make it any easier. However, by utilizing the functions of the online platforms to fit in with the different approaches of learning styles, it enables personalized, engaging, and flexible learning which can improve the learning experience.

LITERATURE REVIEW

There has been a lot of interest and demand for online-based learning, especially in the past few months. Online-based learning can be separated into three main types, asynchronous, synchronous, and hybrid learning (Guo, 2020; Hodges et al., 2020; Nieuwoudt, 2020). Asynchronous learning is the method that uses online platforms without or with minimal real-time interaction. It is a one-way communication that can be received by the participants at their convenience. It can also be defined as back-and-forth message exchanges with a delay in between. In asynchronous learning, the learning materials are provided on any particular online learning platform selected such as Moodle and Open Learning, and can be accessed anytime. This allows flexibility, self-paced, and self-directed learning method for learners who have limited or Internet access issues.

Face-to-face Learning vs Online-based Learning

A Massive Open Online Learning Course (MOOC) is an asynchronous, web-based distance learning program that was created in 2008 as one of the innovations in the education field, that offers university-level courses provided by most reputable universities. It integrates the learning materials that include video lectures, assessments, and interactive tools to replicate the traditional class environment. MOOC platforms such as Open Learning, Khan Academy, Udacity, edX, and Coursera are a few to be named, are some of the most prominent sources that offer online courses (Nguyen, 2015). These courses can be enrolled by the public without any limitation of the location, time, and resources.

MOOCs require individual students to be able to self-regulate their learning, managing their learning pace, determining when and how they engage (Bernacki et al., 2011; Tsai et al., 2018). It typically involves minimal direct interaction between instructors and students. However, it can also be used as supplementary materials in addition to class materials such that being used in the advanced programming course at Universiti Utara Malaysia (UUM). In the previous semesters, students were required to attend the traditional face-to-face classes and they were also required to cover the materials on the Open Learning platform on the same topic for better understanding. The materials uploaded there include additional video lectures and assessments which can be discussed in the classroom if the students require more explanation. They can create and navigate their learning to maintain their learning progress (Littlejohn et al., 2016; Tsai et al., 2018). They can fast-forward, rewind, or skip some parts of the materials per their understanding. This enables fast learners to proceed quicker in the syllabus. The success of MOOCs is largely contributed by the primary factors that are due to the learner's behavior, motivation, goal, self-efficacy, interests, and learning strategies (Bernacki et al., 2011; Milligan et al., 2013; Tsai et al., 2018). Synchronous learning is two-way communication of live learning sessions that happen in real-time where both lecturers and students are required to be online at the same time on the same learning platform and can converse and collaborate (Bouhnik et al., 2014; Heflin et al., 2017). Synchronous learning can be in the form of virtual face-to-face communication such as the use of video conferencing platform (Webex, Zoom, and Google Meet), live streaming through social media platform (Facebook live, YouTube live), and text-based communication through live chat or instant messaging platform (WhatsApp, Telegram). Some of these platforms can be either synchronous or asynchronous depending on how they are being used. These platforms could replicate the feel of an in-class environment virtually. They can be used interchangeably and simultaneously as most students possess at least one mobile device, allowing them to access a variety of online content, information, and social networks (Ally & Prieto-Bl´azquez, 2014; Sarker & Salah, 2019). Even without a computer or laptop, learning can happen as many of the platforms such as Webex, Zoom, and Facebook are accessible and can be participated through the web browser on the mobile device without the need for any installation (Heflin et al., 2017).

Synchronous learning has the advantage of enabling instant engagement and simplify the flood of emails to explain something that could have been resolved in five minutes of virtual face-to-face conversation using video conferencing software. It also allows students with a similar question to be answered at the same time. Real-time conversations, virtual face-to-face, or through another medium that happens in real-time, offer a sense of engagement and connection as if in the traditional face-to-face classes. It is also the quickest way to communicate and collaborate.

A study from Shaw (2012) found that active participation in practicing in programming language learning is superior to just watching the information in an online forum. A prior study by Wang et al. (2011) found that it is essential that students practice and receive constructive and corrective feedback in learning programming. As it might deem difficult and time-consuming to provide instant feedback, it is possible to do so by implementing hybrid learning. Hybrid learning uses the strengths of synchronous and asynchronous learning methods. Many institutions support hybrid learning where live sessions from the video conferencing are recorded and made available to students who are not able to join due to Internet access issues and also for students who would like to replay the lessons in their own time. Shorter

engagement sessions such as the use of instant messaging and forums can be used to discuss the recorded material which can be done in real-time (synchronous) or asynchronously. This shows that there are a variety of approaches that can be opted for in online-based learning.

Even though it can be overwhelming with many platforms, tools, and applications available to be chosen from, most higher education institutions have proposed appropriate selections that are preferred to be used through institutions initiative of subscription to handle hybrid learning. For example, UUM has a subscription to Webex and it is the main video conferencing platform to be used in online-based learning. However, other platforms can also be used if it deems to fit better. This is a golden opportunity for HEIs to test different approaches, platforms, and the experience of online-based learning for future planning, policy development, and training in the field of education.

Student Perceptions

Previous studies by Chis et al. (2018) and Su & Chen (2018) focus on engagement, enjoyment, learning dimensions, and students' motivation. In this research, the questions and statements were grouped into four main sections which are the students' learning preference, engagement, assessment, and students' satisfaction.

Learning preference

As mentioned in the previous section, a wide range of platforms is available to be used in the online learning environment. To get the answer to the first research question which is traditional face-to-face vs online-based and to assess the online platforms used for the learning, students were given multiple options before online-based learning started and at the end of the course, the same question was asked as they now have experienced different platforms and would have their preference.

For online-based learning, in this research, students were asked of their preferences based on the options of (1) synchronous learning through two-way communication on video conferencing platform, (2) synchronous learning through social media, (3) hybrid learning through synchronous text and voice, and pre-recorded video, (4) asynchronous learning using pre-recorded video, and (5) asynchronous independent learning based on the materials uploaded on UUM Online Learning platform.

Learning Engagement

Online-based learning gives students the freedom to be anywhere given that they can get connected to the Internet. Learning environments are the basic components for effective learning activities that feature two main aspects, which are the tangible and intangible aspects (Jou & Wang, 2019). The tangible aspects refer to the physical environment that is closely related to the learning space, which in this research refers to the off-campus locations for the majority of the students.

The second aspect of the learning environment is the intangible aspects that refer to the psychological environments generated through interactions among participants and the physical environment. This can be simplified to suggest the interactions that happen over the Internet concerning the lessons.

Learning Assessment

As online-based learning is more lenient in terms of time, attendance, and materials accessibility, assessments are required as a benchmark to test the students' understanding of the course based on the expected topic that has been covered through the online platform. Students' understanding was assessed in the form of quizzes and practical programming questions (activities) that cover both the theoretical concept and the ability to partially write the code. Studied by Woit & Mason (2003) obtained positive results by

using weekly quizzes as the form of assessment which shows, different types of assessments help ensure students' understanding of programming language.

Prior studies by Wang et al., (2011) and Ala-Mutka (2005) advised on using an automated assessment system for immediate feedback. However, not all aspects of programming can be assessed automatically with precise specifications as it depends on the students' coding style as well. This requires manual inspection that can be time-consuming but more helpful in shaping the students' understanding and good programming construction process. In this research, students are given feedback in the form of automated marking for quizzes, online class discussion, or pre-recorded videos on the sample answers which include reasons and steps to guide in writing the code.

Student Satisfaction

In terms of student's satisfaction, the students' contentment on the overall way that the course was being conducted through the online means were collected which includes the materials delivery through the platforms, assessments, learning expectations, learning materials and resources, and the students' adaptability and attitude towards the online-based learning approach.

METHOD

The purpose of this research is to explore the student's views and perspectives towards the effectiveness of learning programming language through online-based learning. To achieve this objective, the focus group technique has been used in data collection to gather students' views and perspectives regarding the course. Focus groups are very useful to provide information on student's attitudes and experiences about particular programs, services, or relevant issues (Jacobi, 1991; Kaase & Harshbarger, 1993). Nyumba et al., (2018) highlighted focus group popularity as a data collection method in a wide range of studies area due to the capacity to uncover people's perceptions and values.

Participants

A focus group of 31 undergraduate students has been organized with various demographic backgrounds and years of study to capture diverse perspectives based on a range of student experiences. The students involved were from semesters one, two, six, and seven. The participation of the students in the questionnaire was voluntary. Of the 31 students, 25 completed all aspects of the questionnaire. All of the students were enrolled in campus and at the beginning of the online classes, 16% (4) remained on campus, with only 8% (2) chose to re-return to campus, while the rest of them joined the online classes from all over Malaysia, 24% (6) in Kedah, 20% (5) in Penang, 16% (4) in Perak, 12% (3) in Pahang and Selangor, and 4% (1) in Kelantan and Sarawak. The locations of the students play a big part in ensuring the success of the online-based learning as certain locations in the states have a poor Internet connection which affects the ability of the online-based learning to run smoothly in addition to areas that are not covered by the Internet provider to have 4G and the use of fiber optic cables for high-speed Internet. This is one of the reasons for students returning to the campus even though all learning processes were conducted online.

All of the students have experience in the programming language. There are two main programming courses that they need to undertake namely Programming 1 and Programming 2. Programming 1 which is offered in the first semester covers structured programming concepts while Programming 2 which is offered in the second semester covers object-oriented concepts. Both courses are using Java programming language. Students are required to pass the Programming 1 course before they can enroll in the Programming 2 course. This research focuses on Programming 2 students.

The syllabus of the course is separated into 4 topics each, where topics 1-4 were taught using the traditional-based approach that involved face-to-face lectures, in-class exercises and activities, and also lab sessions.

Topic 5-8 were taught using the online-based approach. In both traditional and online-based learning, the teaching materials and related questions and resources are provided upfront on the student portal so that students can self-learn before attending the class.

Pilot Testing

A pre-questionnaire was conducted to identify and collect the data regarding the students' types of Internet subscription and online platforms preference to be used during online-based learning. Before the online-based learning commences, students were briefed on the type and format that will be used, based on the feedback received from the questionnaire. The online-based learning was conducted in line with the existing published timetables to ensure the sense of normalcy continues to exist with the only main difference is in the method of teaching, learning, and assessments. Lab sessions and in-class activities were conducted over the Internet instead of in a physical computer lab setting. Alternative arrangements and forms of assessments were used for lab tests, assignments, quizzes, and other types of assessments to substitute final exams through the university's online learning and other online platforms, which depended solely on the students' Internet connection.

Data Collection and Procedures

Measuring the effectiveness of online-based learning is important to show whether the outcomes of the approaches used meets or exceeds the objectives. It may also help to determine if the approaches and platforms used need to be adjusted or changed (Chimezie, 1986). By accessing the effectiveness of the platforms used, it can serve as a guideline and model that can be identified as the best practice to be implemented by others. Therefore, an evaluation of the conducted online-based learning is needed to point out the strengths and weaknesses of the approaches and platforms, and the need for any changes for improvements.

To measure the effectiveness of learning programming through online-based learning from the perspective of the students, a 7-point semantic differential scale ranging from Never to Always (Snider & Osgood, 1969) are used. Descriptive statistics (mean and standard deviation) were calculated to describe the characteristics of respondents. These indicators were analyzed to understand the effectiveness of learning programming language online perceived by the students.

The questionnaire was developed by referring to previous studies by Chis et al. (2018) and Su & Chen (2018) that focus on engagement, enjoyment, learning dimensions, and students' motivation. In this research, the questions and statements were grouped into four main sections which are the students' learning preference and platforms, engagement, assessment, and students' satisfaction. The questionnaire was distributed at the end of the course to students. The data were collected from 27 July 2020 to 3 August 2020. The questionnaire captured the students' overall views and experience that covers all the necessary parts regarding their learning within the four main sections in the questionnaire.

The first section is regarding the students' learning preferences and platforms. Students compared their learning experience through traditional-based to online-based learning. The follow-up questions in this section concentrate on understanding the reasons for the preferred approach in terms of the ability to adapt, the suitability of the time, and the effectiveness of knowledge transfer through the two main approaches and platforms. The second section is on learning engagement. It probes the questions regarding the applicability of the learning environment outside of the campus and the willingness to immerse in learning. The next section is the learning assessment relevancy towards the learning and teaching processes. This is important as students are expected to be more independent and alert in the code writing processes as typically, in the traditional classes, students can be closely guided when they are unsure of errors that appear on their codes. The last section solicited the students' satisfaction with the overall learning experience and approaches used.

Based on the students' preference of the delivery method (traditional or online-based), the students' performance in Lab Test 1 (covers topic 1-4 through traditional-based learning), and Lab Test 2 (covers topic 5-8 through online-based learning) are compared. In both tests, students are required to write the complete code for a program. The results in terms of the number of students achieving marks above 80% are calculated to determine the effectiveness of the delivery methods and the students' learning preference.

FINDINGS AND DISCUSSIONS

As discussed, a wide range of platforms is available to be used in the online learning environment. To get the answer to the first research question and to assess the online platforms used for the learning, students were given multiple options before online-based learning started and at the end of the course, the same question was asked as they now have experienced different platforms and would have their preference.

Students are given the options of (1) synchronous learning through two-way communication on video conferencing platform, (2) synchronous learning through social media, (3) hybrid learning through synchronous text and voice, and pre-recorded video, (4) asynchronous learning using pre-recorded video, and (5) asynchronous independent learning based on the materials uploaded on UUM Online Learning platform.

Learning Preference: Online versus Traditional

Table 1 shows the students' responses regarding their learning preference. The majority of the students prefer traditional-based than online-based learning (μ=0.566, σ=0.321). However, the students find that online-based learning in programming is also acceptable (μ=0.49, σ=0.325). This shows that both approaches can be used, but it might take some time to get familiar and comfortable in online-based learning and utilizing the platforms as the new norm in education. To further understand if this is the case only for the programming course, the students were asked to rate this statement: "I would like online-based learning to be used throughout my program of study". Based on the response, it shows that in general, students prefer traditional-based learning for all courses (μ=0.460, σ=0.290). This can be concluded that students do have a strong stand regarding their preferred learning approach as the online-based approach is still very new to students. Students agree that if they were to have online-based learning, they are willing to use a wide range of learning platforms (μ=0.597).

Table 1.

Students' learning preference

Learning Preference	Mean (μ)	Std dev (σ)
I prefer traditional-based learning	0.566	0.321
I prefer online-based learning	0.497	0.325
I prefer traditional-based where I have to learn at specific time	0.572	0.384
I prefer online-based where I can learn at my own pace	0.541	0.395
Difficult concepts can be more quickly understood with traditional-based learning	0.597	0.402
Difficult concepts can be better understood with online-based learning	0.398	0.333

Table 2 shows the students' learning platform preference. To understand the effectiveness of using online platforms, students were asked if they prefer Webex (live) or pre-recorded videos. In the live sessions through Webex, students could ask questions during the lesson which all students in the session could benefit from, while through videos, they will send questions that they have through WhatsApp. Based on the responses, both platforms can be used interchangeably and simultaneously where it all depends on the

individual preference, Webex (μ=0.572), and pre-recorded videos (μ=0.534). However, Webex shows a high standard deviation value, σ=0.593 as it largely depends on the types of Internet subscriptions that the students have. Live classes such that on Webex could consume more than 1GB of data per hour as it depends on multiple factors such as the number of participants, frames per second (FPS) setting, and other bandwidth utilization activities. On the other hand, watching a pre-recorded video on YouTube could consume from 264MB to 1.65GB depending on the video quality settings.

To delve further on the reasons for their preference for traditional or online-based learning, students were asked if the time of learning has any effect on them. Most of them prefer a specific time to learn (μ=0.572) rather than having the option to learn at their own pace and revisit the materials outside of class time (μ=0.541). However, students with limited Internet prefer to learn at their own pace as there is a certain period in their Internet subscription that allows unlimited or better connection.

In online-based learning, students are expected to attend the class virtually by either on live Webex sessions or by watching the pre-recorded videos during the specific class time as the content provided is exactly what would be covered during the traditional-based learning. To enforce students' participation in the online-based learning, attendance was taken based on the completion of activity in the form of quizzes at the end of the class. This was done as the consideration to the students who were not able to join the class at the specific time to have a chance to self-study the required materials at a later time. However, it was observed that there were students who attempted the quiz without trying to understand the learning materials based on the activity's mark (0%).

In terms of understanding the content of programming, the students strongly believe that difficult concepts can be quickly understood with traditional-based learning (μ=0.597) than online-based learning (μ=0.398). This is expected as in traditional face-to-face learning, students can easily ask more questions to verify their understanding during the lesson or lab session, and able to discuss amongst their peers. However, in online-based learning, through observation, students tend to try and understand the difficult concepts individually during class. They tend to ask for verification several hours after the classes have ended and before the next class time slot through individual WhatsApp message.

Table 2.

Students' learning platform preference

Learning Platforms	Mean (μ)	Std dev (σ)
I prefer the lessons to be live on Webex	0.572	0.593
I prefer the lessons to be recorded on videos	0.534	0.347
Online-based learning through Webex is more effective than traditional-based learning	0.466	0.321
Online-based learning through recorded videos is more effective than traditional-based learning	0.503	0.184

In terms of the effectiveness of the platforms, pre-recorded videos show a higher mean value than Webex, μ=0.503 with a low standard deviation, σ=0.184. This could be because pre-recorded videos can be viewed and replayed, while on Webex, even though the session is recorded, the video is not shared amongst the students. Students can pause the pre-recorded video and search for more information on the Internet for clarification while during live Webex, they have to focus on the class.

Learning Engagement

In terms of the suitability of the physical learning environment, as shown in Table 3, it shows the mean of 0.541 which on average, most students agree that they are able to focus on online-based learning. However, on closer inspection, based on the individual feedback, 13.04% of the number of students were not able to join many of the live Webex sessions as the students' locations have limited Internet coverage which is not the ideal environment for online-based learning. 4.35% (1) student chose to remain on campus in order to participate in online-based learning due to the stable Internet connection provided by the university without limitation.

Table 3.

Online-based learning engagement

Learning Engagement	Mean (μ)	Std dev (σ)
The learning environment is suitable for me to participate in online-based learning.	0.541	0.339
In online-based learning, I ask more questions to my lecturer	0.435	0.198

The majority of the students have Internet connection problems which cause lagging, unclear, and distorted voices and videos. This is due to their typed of subscribed Internet connection. The majority of the students, 78.27% (18) have Internet limitations in terms of limited data, limited speed, unlimited data but has capping speed or limited data but unlimited on chat and socials. 52.17% (12) of the students rely heavily on mobile data and the Internet while 43.48% (10) of the students use broadband. Thus, several platforms such as Webex, pre-recorded videos on YouTube and Facebook, UUM Online Learning, and WhatsApp are used interchangeably and simultaneously to minimize this limitation as it is impossible to overcome it as it is related to the Internet infrastructure and coverage in Malaysia.

The second aspect of the learning environment is the intangible aspects which is the interactions regarding the lessons over the Internet. Based on the result shown in Table 3, less than half of the students (μ=0.435) agree that they ask more questions in online-based learning. However, it was observed that students who asked questions during and after the live online sessions tend to be more specific on their queries and have a well-developed understanding of the content. It was also observed that students who typically ask questions during the face-to-face classes were also more opened to ask questions during live online sessions.

Learning Assessment

Table 4 shows the students' perception of online learning assessments. Overall, the majority of the students agree that the activities and quizzes help ensure their understanding with a high mean of μ=0.590. However, it shows a slightly lower mean value of μ=0.503 in agreeing in terms of their self-satisfaction in completing the activities because typically, in a traditional class, students can ask for clarification while completing the activities as programming is more on hands-on and lab sessions where the activities are concentrating in writing the codes. This is the reason for the high standard deviation value of σ=0.469 in terms of the helpfulness of the quizzes and activities as certain students require extra help and guidance to fully understand the topic. Many of the students (μ=0.516) with a low standard deviation of σ=0.209 agree that they are motivated to complete the activities as these serve as a sense of accomplishment at the end of every class.

Table 4

Students' perception of the online learning assessment

Learning Assessment	Mean (μ)	Std dev (σ)
I felt motivated to complete the online-based learning activities	0.516	0.290
I am satisfied with the work I did on the online activities	0.503	0.340
Online quizzes and activities are helpful for me	0.590	0.469

Student Satisfaction

In terms of students' satisfaction, it can be concluded that the majority of the students are contented with the way the course was being conducted through the online means as shown in Table 5. The students agree that overall, they liked learning through online platforms (μ=0.572) and online classes, which are live through Webex, pre-recorded videos and the use of WhatsApp enhanced the students' experience in programming (μ=0.5150, σ=0.290). 56.52% of the students agree that they had to work harder in online classes (μ=0.659, σ=0.605) where 26% (6) feels strongly about it while 39.13% thought otherwise with 17.39% (4) strongly disagree. This could be due to more assessments being carried out than during traditional-based learning where students are expected to have the initiative to self-learn and refer to various resources when attempting the assessments to fully understand the content. This shows the different types of students and their willingness to go the extra miles and their attitude towards learning, thus the high standard deviation value indication as some had difficulties in adjusting to the unfamiliar online approaches. However, it can be concluded that students are aware that as classes are online-based, they are required to do more background reading before and after each class, to be able to engage and query for more explanation during online discussions.

Table 5

Students' satisfaction on online-based learning

Student Satisfaction	Mean (μ)	Std dev (σ)
Overall, I liked learning through online platforms	0.572	0.312
I feel that online-based learning enhanced my experience in this course	0.510	0.290
I feel that the quizzes and activities are beneficial for my understanding	0.621	0.496
I had to work harder in the online-based learning	0.659	0.605

Despite the increasing number of assessments, the majority of the students firmly believe that the quizzes and activities are beneficial in increasing their understanding (μ=0.621) as the questions provided covered all parts of the topics to ensure the learning outcomes are attained. This is reflected in lab test results where Lab Test 1 was based on topics that were taught traditionally where 25.81% obtained marks above 80% while in Lab Test 2 that was online-based, 48.39% which is nearly doubled of students who obtained above 80% compared to the previous test even though test 2 was more difficult and covered more complicated concepts. This indicates that regardless of the delivery mode, students can perform well. This shows a high possibility to achieve better results than in traditional-based learning with the mastery of online platforms in conducting effective online-based learning.

CONCLUSIONS

Online-based learning is the new norm in the Covid-19 pandemic era, replacing traditional face-to-face learning to ensure continuous learning. This research was conducted to view the effectiveness of learning programming language amongst the undergraduate students in Universiti Utara Malaysia, using the online approaches in the aspects of students' learning preference, engagement, assessment, and satisfaction. It was found that students are willing to participate and use multiple synchronous and asynchronous platforms to ensure a smooth online-based learning experience. Based on the analyzed findings, online-based learning shows a promising result and can be considered as the future of education as students showed improved performance results compared to traditional-based learning. Rigorous research on the online-based learning in terms of the (1) learning materials and assessments, (2) students' adaptability, independent learning skills individually and collaboratively, and (3) the suitability of the technologies used to mediate learning should be further studied to understand this matter in more detail.

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