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The Role of Digital Collaboration in Student Engagement towards Enhancing Student Participation during COVID-19

Sharmini Gopinathan [1,*], Anisha Haveena Kaur [1], Segaran Veeraya [2] and Murali Raman [2]

[1] Faculty of Management, Multimedia University, Cyberjaya 63000, Malaysia; 1112700541@student.mmu.edu.my
[2] Graduate School of Business, Asia Pacific University, Kuala Lumpur 57000, Malaysia; roysegaran@yahoo.com (S.V.); murali@apu.edu.my (M.R.)
* Correspondence: sharmini.gopinathan@mmu.edu.my

Abstract: As Malaysia's educational landscape continues to evolve, there is a need to rethink the models and practices involved in the teaching and learning process. The coronavirus disease (COVID-19) pandemic, subsequent lockdowns, and movement control restrictions have contributed to the shift in education, especially in teaching and learning. Educational institutions were instructed to close during the lockdowns and this forced educators and students to communicate and engage using digital technologies. Students have no issues when it comes to embracing technology, but their ability to stay engaged and participate during lessons was of concern to educators. According to recent research, collaborative learning has been shown to be enjoyable and engaging for students, especially when it is conducted digitally using innovative learning technologies. When students show an increased level of engagement, it shows that they are actively participating and are more involved during lessons. This quantitative study looks into the relationship between variables pertaining to digital collaboration (personal factors, environmental factors, social media support, digital collaborative tools, interactivity, motivation) and student engagement toward enhanced student participation during COVID-19. The study utilizes Lev Vygotsky's Collaborative Learning Theory alongside Albert Bandura's Social Learning Theory. The data analysis revealed that there is a positive significant relationship between digital collaborative tools, interactivity, and motivation towards student engagement, which in turn proved that there is a positive significant relationship that can be drawn between student engagement and enhanced student participation during COVID-19.

Keywords: collaborative learning; digital collaboration; student participation; global digital collaboration

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1. Introduction

The outbreak of an infectious disease caused by the SARS-CoV-2 virus emerged in December 2019 and caught the world by surprise [1]. Many industries and sectors were affected by the pandemic, as they were required to close throughout the movement control order (MCO) [2]. Only essential services such as food supplies, utilities, health, banking, telecommunications, and cleaning were allowed to operate, but with strict standard operating procedures (SOP) [3]. The education sector was one of the many sectors that were affected by the pandemic. Schools and higher learning institutions were required to close in order to limit the transmission of the virus. Teachers and lecturers who had been complacent in conducting face-to-face classes had to immediately switch to online teaching. This was seen as a nail-biting situation for educators and some students. According to Al-Kumaim et al. [4], some university students had experience with online distance learning (ODL), but there were some who may not have been exposed to ODL at all. However, regardless of whether one had experience with ODL or not, the pandemic forced students and educators alike to quickly adopt the use of technologies in the teaching and learning process [5].

In a policy brief by the United Nations (UN), it was explained that web-based class meetings are useful tools when it comes to communicating with learners and the education community during the pandemic [6]. That being said, educators sought after the use of Google Meet or Zoom to conduct classes online and managed to prepare for lessons with the aid of technology [7]. Many educators sought materials that are readily available online to aid their delivery. Some creative educators even opted to create their own content.

Problem Statement

The COVID-19 pandemic caused higher learning institutions to postpone or cancel face-to-face classes in order to safeguard the safety of the students, lecturers, and supporting community. In research conducted by Bahar et al. [8], more than a few challenges were found from the educator–student perspective in Malaysia relating to technology incompetence, ineffective real-time communications, a low rate of interactivity, and a lack of understanding of learners' characteristics and attitudes. Educators in particular were struggling to transform their content online. Students had no issues embracing technology, but their participation and discipline in staying attentive in online classes posed a troubling situation for the educators. Lack of trust in students and wondering what was happening behind the camera was constantly an issue. Emerging and online technologies have a strong influence in the use of tools in online learning environments [9]. According to Bergdahl et al. [10], these technologies reshaped student engagement for learning through new features. Universities and educational institutions had no choice but to engage and communicate via digital technologies. Student engagement is of utmost importance and plays a vital role in satisfaction and students' continuous learning [11]. New digital tools were deployed and used during this sudden transition for the first time by both the educators and learners [12]. This caused unwanted stress and shock among students and educators since it was sudden and unplanned. Furthermore, educators were put under the stress of coming up with new ideas to attract the attention and participation of students.

Bahar et al. [8] suggested using collaborative learning and collaborative tools as one of the workarounds to mitigate the challenges. Collaborative learning has been the forefront of education in the last decade. The benefits of collaborative learning include enhanced student thinking, especially in aiding higher-order thinking skills among students. Universities have implemented various tools, techniques, and pedagogies that promote collaborative learning among students and educators. However, this is not a norm in Malaysian universities, where face-to-face and hybrid sessions were quite popular before the pandemic. This study seeks to unveil the relationship between factors of collaborative learning and student engagement towards increasing student participation during and post COVID-19 movement restriction in the country. Consequently, the following research questions drove the current study:

1. What is the relationship between personal factors and student engagement towards enhanced student participation?
2. What is the relationship between environmental factors and student engagement towards enhanced student participation?
3. What is the relationship between social media support and student engagement towards enhanced student participation?
4. What is the relationship between interactivity and student engagement towards enhanced student participation?
5. What is the relationship between digital collaborative tools and student engagement towards enhanced student participation?
6. What is the relationship between motivation and student engagement towards enhanced student participation?
7. What is the relationship of student engagement towards enhanced student participation?

This study investigates the personal factors, environmental factors, social media support, interactivity, digital collaborative tools, motivation, and enhanced student participation of students. Therefore, this research aims to achieve the following objectives:

1. To investigate the relationship between personal factors and student engagement towards enhanced student participation.
2. To investigate the relationship between environmental factors and student engagement towards enhanced student participation.
3. To investigate the relationship between social media support and student engagement towards enhanced student participation.
4. To investigate the relationship between interactivity and student engagement towards enhanced student participation.
5. To investigate the relationship between digital collaborative tools and student engagement towards enhanced student participation.
6. To investigate the relationship between motivation and student engagement towards enhanced student participation.
7. To investigate the relationship of student engagement towards enhanced student participation.

2. Literature Review

The materials needed to conduct a literature review for this study were attained from several databases, namely, Science Direct, Emerald, Google Scholar, ProQuest, JSTOR, Sage Publications, and Springer Link. The inclusion criteria for the material search in these databases were research articles, review papers, conference proceedings, books, and book chapters published between 2007 and 2022. Additionally, backwards searching was also applied in the search for relevant materials. This method allows researchers to review references that are cited in the articles. Keywords and key phrases were used to search for relevant literature for this study. According to Siddiqi and Sharan [13], a keyword represents a single word term, whereas a key phrase describes a multi-word lexeme. The selection of keywords and key phrases plays an important role in search activity. In certain instances, the literature search results obtained from the keywords and key phrases tend to not match the requirements of the research topic. Therefore, Boolean operators were used to address this issue. Boolean operators include the use of AND, OR, and NOT when combining two keywords or key phrases [14]. The keywords and key phrases used for the literature search were "digital collaboration," "digital collaborative tools," "personal factors," "environmental factors," "social media," "social media support," "interactivity," "interaction," "motivation," "student engagement," and "student participation." In addition, Table 1 has been included to show a summary of the literature review from various perspectives that are relevant to digital collaboration.

Table 1. Summary of the literature review.

			Topic/Concept					Methodology			
No.	**Author(s)**	**Year**	**Digital Collaboration**	**Student Engagement**	**Student Participation**	**Collaborative Learning**	**Social Learning**	**Framework/Model**	**Survey/Observation**	**Review**	**Theory Building**
1	Bandura	1977					/				/
2	Vygotsky	1978				/					/
3	Webb	1982				/	/		/		
4	Bruffee	1983				/				/	
5	Johnson and Johnson	1989				/				/	
6	Connel and Wellborn	1991		/				/		/	

Table 1. *Cont.*

No.	Author(s)	Year	Topic/Concept					Methodology			
			Digital Collaboration	Student Engagement	Student Participation	Collaborative Learning	Social Learning	Framework/Model	Survey/Observation	Review	Theory Building
7	Skinner and Belmont	1993		/				/	/		
8	Bruffee	1995				/				/	
9	Welch	1998				/				/	
10	Panitz	1999				/				/	
11	Austin	2000				/				/	
12	Leonard and Leonard	2001				/				/	
13	Paswan and Young	2002		/	/			/	/		
14	Garrison and Cleaveland-Innes	2005		/	/				/		
15	Collazos et al.	2007				/			/		
16	Anderson	2007	/			/				/	
17	Fu and Ho	2009	/	/		/		/	/		
18	Shabani et al.	2010				/				/	
19	Jarvela et al.	2010				/	/		/		
20	Laal and Ghodsi	2012	/							/	
21	Romero et al.	2012				/				/	
22	Blasco-Arcas et al.	2013		/		/		/	/		
23	Kuo et al.	2014	/						/		
24	Pellas and Kazanidis	2015	/	/			/		/		
25	Northey et al.	2015		/					/		
26	Potter	2015	/			/			/		
27	Montrieux et al.	2015	/						/		
28	Chiero et al.	2015	/						/		
29	Fedynich et al.	2015	/						/		
30	Deaton	2015					/			/	
31	González-Gómez et al.	2016	/			/			/		
32	Lancelloti et al.	2016	/						/		
33	Bembenutty et al.	2016					/			/	
34	Vuopala et al.	2016	/			/			/		
35	Al-Rahmi and Zeki	2017	/			/		/	/		
36	Nortvig et al.	2018	/	/						/	
37	Rashid et al.	2019	/			/			/		
38	Hernández-Sellés et al.	2019	/			/	/		/		
39	Dakhi et al.	2020	/		/					/	
40	Rospigliosi	2020	/			/				/	
41	Syani et al.	2020	/						/		
42	Amin and Sunadri	2020	/		/				/		
43	Baanqud et al.	2020	/	/		/		/	/		
44	Shenoy et al.	2020		/					/		
45	Yee and Yunus	2021	/			/				/	

2.1. Digital Collaboration

According to Laal and Ghodsi [15], when groups of learners and teachers work together to complete a task, solve a problem, or create a product, collaborative learning occurs. The research further suggests and elaborates that collaborative learning is all about cooperation in contrast to competition, since working via consensus building contributes many benefits. Researchers from earlier years began looking extensively into collaboration as a promising mode of human engagement [16,17]. The need to work and think together

on issues that need critical thinking increased since it attempted to shift the stress from the individual to teamwork. This model of working shifted working from autonomy to the community [18]. Therefore, the process of participating in knowledge communities has been termed "collaborative learning," where knowledge is assimilated through collective understanding and sharing [19,20]. The main idea here is to participate as a community of learners where the distribution of expertise happens by sharing, learning, and engaging through the expansion of a community of research practice [21].

When small groups work towards a common goal via collaborative learning, the learners with various performance levels work together and are responsible for one another's learning. Lots of benefits are achieved through collaborative learning, and research by Panitz [22] summarized them into social, psychological, academic, and assessment [23]. Some of the benefits are that it aids the development of a social support system for learners, student-centered instructions increase students' self-esteem (motivation), behavior change (positive attitude) occurs, it promotes critical thinking skills, students actively get engaged in the learning process and with the latest digital and collaborative teaching methods, and assessment techniques can be easily customized. According to Panitz [22], when students interact and work together the learning process becomes interesting thus skills approximating to higher-level thinking are developed by collaborative learning [24].

Hence, to improve the quality of learning and teaching online, applications such as learning management systems (LMS), Google Meet, Google Classroom, Zoom, and MS Teams, called collaborative tools, are used. Collaboration is a process of working in groups or pairs by learners, supported by teachers/educators with communication to accomplish the goals of the lesson [25]. Moving forward in the digital age, collaborative learning is increasingly used and getting a lot of support from students, learners, educators, and parents. This was evident and became prevalent during the COVID-19 due to restrictions not allowing students to go to their face-to-face classes. A collaborative learning environment needs careful design and tools to support learning. A study by Collazos et al. [26] on collaborative learning environments using digital games showed significant support, and at least four elements, namely, people, activities, tools, and objects, were considered to develop the environment for a game-based learning approach. The study identified that well-specified environments induced collaborative learning. So, the results of the research indicated that other aspects such as participation and learning goals with a combination of effective indicators are more important for the collaboration process than the design of the tools themselves. This research explored those constructs together with digital collaboration tools to enhance students' engagement towards enhanced participation [26].

An increase in the deployment and usage of digital technology integration has brought lots of positive changes to the education system. This has improved digital skills for both students and educators. It is not easy to engage digital technology in the learning process without a change in the mindset of learners and educators, since they will need to use and work with collaborative digital tools [27]. The phrase "online learning" typically refers to learning management systems (LMS) such as Blackboard and Moodle [28]. This kind of setting works well in the absence of a physical classroom with the assistance of web-based and cloud-based technologies working on collaborative learning tools independent of place, time, and pace [29,30]. The literature by Nortvig et al. [31] states that using online teaching shifts the learning environment to a more social, flexible, and personal space for the user. This promotes a social constructivist approach to learning that encourages problem-solving that is very much student-centric [32]. Students consider web-based lectures from the collaborative tool sessions to be an added value, according to Montrieux et al. [33], especially during course preparation. In the findings by Lancellotti et al. [34], web-based lectures consolidate knowledge and improve learning across gender and ethnic groups. Furthermore, other studies from Chiero et al. [35] and Fedynich et al. [36] stated that interaction among educators and students online contributes to learning outcomes and satisfaction that leads to better engagement amongst students. A literature review conducted by Nortvig et al. [31] on factors influencing e-learning and blended learning leading to student satisfaction and

engagement suggested that further research is needed to better understand what influences students' learning experiences in online formats. Thus, with digital collaborative tools, things suggested in the study such as interactions between students, learners and content; educator presence; and connections between offline and online activities can be easily made available for successful engagement through the use of digital tools.

The COVID-19 pandemic has affected not only human lives and the health system but also has affected the socio-economic system of the world, bringing things to a standstill. This did not spare the education system during the pandemic era either, wherein alternative measures had to be taken to endure and proceed with education [37]. The pandemic disrupted the education system in Malaysia, both public and private, and many institutions had to postpone or cancel face-to-face classes to safeguard the safety of the students, lecturers, and supporting community. At large, everyone was in fear of the COVID-19 virus and subsequent mutation of the virus evolving, and many restrictions had to be in place to stop the virus from spreading [38]. During this time, digitalization and digital transformation accelerated exponentially [39,40] and tools (e.g., Google Meet, Google Classroom, Zoom, Microsoft Teams, Moodle, LMS, Skype, Loom, Prezi, Kahoot, and YouTube) gradually gaining pace from year to year suddenly had to be introduced with no choice to substitute face-to-face teaching and learning drastically [41]. The study also indicated that students from Indonesia still preferred face-to-face teaching as opposed to using the tools, and therefore opened an area to check whether Malaysian students view this differently.

In a study by Baanqud et al. [42], the most significant outcome in the research was that the cloud environment was able to foster the development of students' knowledge while learning how to collaborate online. This prompted the researchers to investigate whether a similar outcome can lead to student engagement in Malaysia to collaborate online, thus enhancing their participation and knowledge retention. Another study undertaken by Yee and Yunus [43] in Malaysia showed other interesting findings, since English is a second language, and that hampered many Malaysian students from effectively using the digital collaboration tools. Thus, with digital collaborative tools that have inbuilt English correction features, it could bring more benefits than harm to the students and the education system. Although there are challenges, other factors suggested in this study could contribute to and overcome the challenges through online sessions and digital collaborative tools to get students engaged and enhance their participation. In a study by Shenoy et al. [44], during COVID-19 in India, there was lots of fear and anxiety amongst students and education faculty regarding the way forward with education in terms of COVID-19. The study on adapting to technology exhibited a positive note on how students quickly engaged in various virtual sessions. This research also mentioned resistance towards adapting to virtual engagement and adapting technology from the teaching fraternity, but later the higher education system in Bangalore widely adopted digital technology and students' involvement was higher than during regular class engagement. This opens the door for the proposed research to look into other constructs together with the digital collaborative tools in order to achieve student engagement and enhanced participation.

2.2. Theoretical Model

The theoretical model of this study was developed based on the concepts of collaborative learning theory and social learning theory. Collaborative learning theory stems from Vygotsky's [45] concept of the zone of proximal development. The zone of proximal development is best described as the distance between the learner's actual level of development, which is determined by independent problem solving, and their potential development through problem solving (mediating semiotic approaches and environmental tools) under adult facilitation or with capable peers [45,46]. To simplify, learners depend on and learn from each other by working together to complete tasks or solve problems. Vygotsky [45] also acknowledges that learning requires social interaction and thus views learning as a social process whereby dialogue and language are important in enhancing

cognitive development. Teamwork and human interaction go hand in hand. Hence, to further understand how learners actually learn in social contexts, social learning theories are applied [47]. According to Culatta [48], Bandura's [49] social learning theory is related to that of Vygotsky's, which also focuses on social learning.

Social learning theory explains that learning occurs through observation, imitation, and modeling. The theory is based on the idea that people learn from their interactions with others in a social setting. When people observe the behavior of others, they tend to assimilate and imitate the behavior. Additionally, social learning theory acts as a bridge between the cognitive approach and behaviorist approach (a traditional learning theory) to learning, as it includes attention, memory, and motivation [50]. Bandura's theory also provides a framework for us to understand, predict, and, in some instances, change learners' behavior. The social learning theory describes learners' behavior using a reciprocal model where personal factors (cognition, self-efficacy, and affective states), environmental factors (learning environment), and behavior (self-regulated learning using strategies and adapting) continuously interact with one another [51].

Knowledge exchange in an interactive environment is also needed in order for social learning to occur [52]. When there is no platform for interaction, learners' self-efficacy is restricted, thus causing student engagement to be compromised. Social media can be classified as an interactive platform and channel where knowledge is spread between learners and communities [53]. Apart from encouraging social interaction among learners, social media is also seen as a tool that encourages collaborative learning. According to Anderson [54], the presence of social media in teaching and learning processes allows learners to communicate better with their peers when it comes to problem solving or completing tasks in a collaborative environment. Additionally, learners are encouraged to develop an online presence using the integration of technology that allows them to synchronously and asynchronously share information online [55]. Learners may opt for digital collaborative tools such as online document collaborations, online discussion boards, and other online collaboration platforms. These tools allow learners to solve complex problems and improve social interaction simultaneously. Since COVID-19 has affected face-to-face lessons in higher learning institutions, interactive platforms and digital collaborative tools allow learners to collaborate and interact remotely from their respective locations.

Studies have also emphasized the importance of interactivity when it comes to collaborative learning. There are two types of interactions, namely, teacher–student interaction and student–student interaction. Teacher–student interaction is vital, especially in technology-mediated education, as it enhances learning, eradicates feelings of loneliness, and promotes engagement [56–59]. Furthermore, students who receive timely feedback from their instructors are more confident to participate in class and are able to see improvements in terms of performance. Hernández et al. [59] explained that interactivity between instructors and students allows the former to provide input to students during lessons, promote collaborative learning, enhance engagement, and increase student participation. On the other hand, interaction between learners that is promoted by social technologies also plays an important role when it comes to collaborative learning [60]. Vuopala et al. [61] explained that in order to attain collaborative learning success, there must be peer interaction between learners. This sort of interaction is vital, as it helps improve student engagement, interest, and motivation during lessons [62].

Another key factor to look into when discussing these two theories is the fact that each learner (within collaborative groups) is a self-regulating agent that has unique emotions and cognitions [63]. This leads to the importance of understanding the learner's motivation in a social interactive context. According to Jarvela et al. [63], motivation in the learning context can be described as the psychological drive that will lead to the learner's cognitive engagement, and eventually, their achievement. With motivation, student engagement will be optimized when the social context fulfils the learner's basic psychological needs, which include the need to be competent, the need to be autonomous, and the need to relate to others [64,65]

Based on the literature that has been discussed, the following constructs in Table 2 were derived. The research aims to look into the role of personal factors, environmental factors, social media support, interactivity, digital collaborative tools, and motivation in increasing student engagement, which in turn enhances student participation. Figure 1 depicts the research model of this study.

Table 2. Operational definition of the constructs.

Construct	Operational Definition
Personal factors	A particular background of an individual's life and the feeling that can impact functioning positively or negatively [66].
Environmental factors	The external learning environment, which dramatically affects the learning outcomes of students, such as space, comfort, communication, noise levels etc. [67]
Social media support	The use of social media in supporting teaching and learning [68].
Interactivity	Interactivity is the extent to which an educator expects communication from students while teaching [69].
Digital collaborative tools	Digital collaborative tools are tools or platforms to aid the practice of people working together online or remotely [70].
Motivation	The reasons for doing something, or the level of desire to do something [71].
Student participation	Student participation is taking part and joining in a dialogue for engaged and active learning in online classes [72].

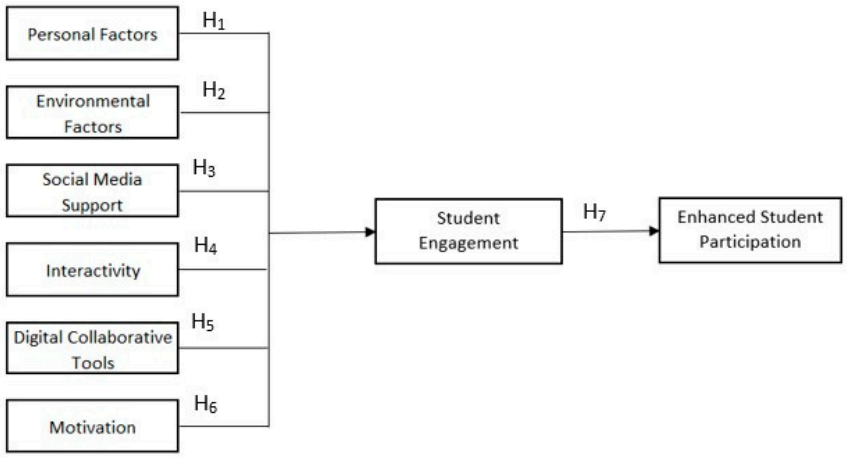

Figure 1. Research model.

Thus, based on the research framework and literature review, the following hypotheses were derived to explore the role of digital collaboration and its relationship with student engagement and enhanced student participation. Hence, the hypotheses derived are:

Hypotheses 1. *There is a significant relationship between personal factors and student engagement.*

Hypotheses 2. *There is a significant relationship between environmental factors and student engagement.*

Hypotheses 3. *There is a significant relationship between social media support and student engagement.*

Hypotheses 4. *There is a significant relationship between interactivity and student engagement.*

Hypotheses 5. *There is a significant relationship between digital collaborative tools and student engagement.*

Hypotheses 6. *There is a significant relationship between motivation and student engagement.*

Hypotheses 7. *There is a significant relationship between student engagement and enhanced student participation.*

3. Methods

This research is quantitative in nature, whereby data were collected from respondents via questionnaire. The working population for this study constituted Malaysian undergraduate and postgraduate students who were participating in digital collaboration during classes throughout the COVID-19 pandemic. The questionnaire for this study was carefully prepared with the anonymity of the respondents safeguarded. Each item in the questionnaire was measured using a 5-point Likert scale, which ranged from strongly disagree (1st point) to strongly agree (5th point). A final total of 142 responses were attained. 122 respondents were undergraduate students and 20 respondents were postgraduate students. Table 3 depicts the research design components of this study alongside their respective rationalizations. The information that is collected is as great as the instrument that collects the information. An ineffectively planned instrument will lead to bad information, which can lead to terrible conclusions. Thus, creating a great instrument is the foremost critical portion of conducting a high-quality inquiry about what to think about. The instrument was developed based on items from various theories, primarily Vygotsky's Theory of Collaborative and Social Learning. These measurement items were carefully adopted and adapted to suit the current study. The instruments developed went through four main areas, as suggested by Davis [73], which are the identification of concepts, the construction of items, validity testing, and reliability testing. In this study, the concept based on each variable and its relevance to the theory was identified and the measurement items were carefully curated to reflect the variable being measured, as shown in Table 4.

Table 3. Research design elements.

Research Design Component	Description	Rationalization
Nature of study	Exploratory	The premise of this research is to determine whether digital collaboration plays a role in increasing student engagement, which in turn enhances student participation in classes during COVID-19.
Role of theory	To test the theory	In order to test the hypothetical framework for this study, a deductive approach was employed. The research looks into the role of personal factors, environmental factors, social media support, interactivity, digital collaborative tools, and motivation in increasing student engagement, which in turn enhances student participation.
Sampling process	Purposive sampling	The respondents were determined and selected based on the following criteria: (i) have access to high-speed internet, (ii) participate in online classes during the pandemic, and (iii) are familiar with online teaching and learning technologies.
Data collection technique	Surveys	A questionnaire was prepared using Google Forms and was distributed to undergraduate and postgraduate students in Malaysia via social media platforms and WhatsApp. As per the G*Power analysis, a minimum of 123 respondents were required for this study. A total of 147 responses were collected within a time period of one month. However, only 142 responses were applicable for data analysis after straight lining was conducted.
Researcher interference	Minimal	There was minimal interference to the work nature and activities of the students by the researchers during the distribution and collection of the questionnaire.

Table 4. Instrumentation of the questionnaire.

Construct	Description of Measurements	Sources
Personal factors	Self-efficacy, sense of accomplishment, observation of others, self-confidence.	Al-Kumaim et al. [4], Bembenutty et al. [51], Tosterud et al. [74], Tsai et al. [75], Wang et al. [76]
Environmental factors	Communication, cultural background, connectivity, noise, and temperature.	Adnan and Anwar [77], Aguilera-Hermida [78], Bembenutty et al. [51], Hamid et al. [79], Hill et al. [80]
Social media support	Utilization, tool to understand related topics, supports class-related activities, content sharing, knowledge sharing, attains updated information.	Alshuaibi et al. [81], DeAndrea et al. [82], Roopchund et al. [83]
Interactivity	Access, participation, visibility.	Panigrahi et al. [84], Park and Kim [85], Roque-Hernández et al. [86], Vuopala et al. [61]
Motivation	Effort, receiving feedback, encouragement, accomplishment, challenges to overcome, value.	Alioon and Delialioğlu [87], Kikuchi [88], Pahlepi and Nurcahyo [89], Ryan and Deci [90]
Student engagement	Voluntarily provides input, voluntarily asks questions, ownership of learning process, going beyond what is required, invests more time and effort, involvement in meaningful activities.	Dyment et al. [91], Fredricks and McColskey [92], Kuh [93], Veiga et al. [94], Yurco [95]
Student participation	Participative, makes decisions, work completion, uses digital tools to work outside of class hours.	Khatoon [96], Macnaught and Yates [97], Neuwirth et al. [98]

4. Data Analysis

The SmartPLS 3 software was used to analyze the data for this study. The software allows researchers to analyze inter-relationships between variables, whereby single or multiple regressions can be stated.

4.1. Measurement Model Evaluation

Measurement model evaluation is required to affirm the reliability and validity of the research model. The data attained from the questionnaires were used to structure the measurement model of this study.

The correlation coefficient for the variable and factor is known as factor loading. The variance explained by the variable on that particular factor is shown by factor loadings. In the SEM approach, a factor loading of 0.708 or higher indicates that the factor extracts enough variance from the variable [99]. The reliability indicator for this study was evaluated by ensuring that each item's factor loadings was above the 0.708 threshold. However, factors loadings lower than 0.708 were accepted as long as it was within a satisfactory threshold. Table 5 shows the factor loadings of the items that fell within the satisfactory threshold, thus confirming the presence of indicator reliability. As for the internal consistency reliability, it was determined by the composite reliability (CR), which has to show a value above 0.70. CR is an alternative measure of internal consistency similar to Cronbach's alpha (CA). Table 5 affirms that the CR for each construct was above 0.70, thus confirming that there was internal consistency reliability. The convergent validity of the study was determined by the average variance extracted (AVE), whereby the AVE value of each construct had to be more than 0.50. Table 5 shows that the AVE for each construct was above 0.50, thus signifying that there was a satisfactory level of convergent validity. Figure 2 depicts the measurement model of this study.

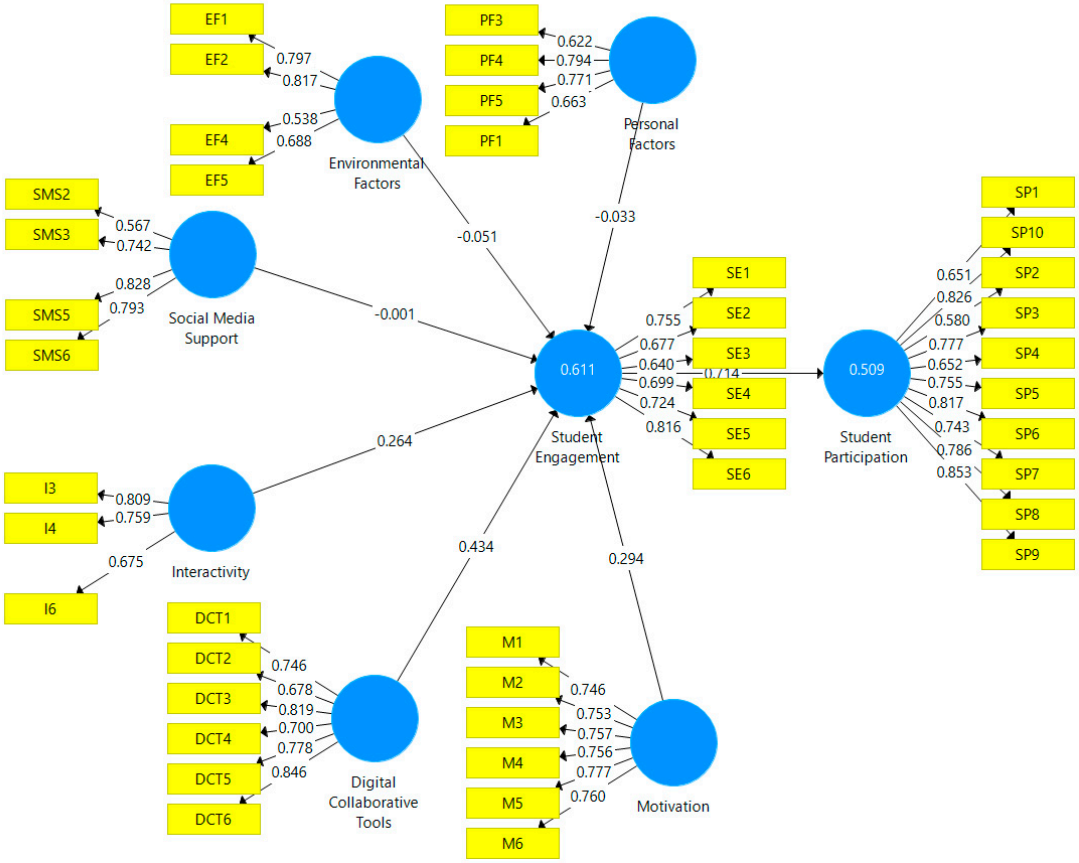

Figure 2. Measurement model.

Table 5. Items, loadings, average variance extracted (AVE), and composite reliability (CR) of each construct.

Constructs	Items	Loadings	AVE	CR
Digital collaborative tools	DCT1	0.746	0.583	0.893
	DCT2	0.678		
	DCT3	0.819		
	DCT4	0.7		
	DCT5	0.778		
	DCT6	0.846		
Environmental factors	EF1	0.797	0.516	0.807
	EF2	0.817		
	EF4	0.538		
	EF5	0.688		
Interactivity	I3	0.809	0.562	0.793
	I4	0.759		
	I6	0.675		
Motivation	M1	0.746	0.575	0.89
	M2	0.753		
	M3	0.757		
	M4	0.756		
	M5	0.777		
	M6	0.76		

Table 5. *Cont.*

Constructs	Items	Loadings	AVE	CR
Personal factors	PF1	0.663	0.513	0.807
	PF3	0.622		
	PF4	0.794		
	PF5	0.771		
Social media support	SMS2	0.567	0.546	0.826
	SMS3	0.742		
	SMS5	0.828		
	SMS6	0.793		
Student engagement	SE1	0.755	0.519	0.866
	SE2	0.677		
	SE3	0.64		
	SE4	0.699		
	SE5	0.724		
	SE6	0.816		
Student participation	SP1	0.651	0.561	0.926
	SP2	0.58		
	SP3	0.777		
	SP4	0.652		
	SP5	0.755		
	SP6	0.817		
	SP7	0.743		
	SP8	0.786		
	SP9	0.853		
	SP10	0.826		

The purpose of discriminant validity testing is to guarantee that a reflective construct has the strongest correlations with its own indicators. The discriminant validity is assessed using the Fornell and Larcker criterion. Based on this criterion, an item must have a stronger loading on its own construct compared to other constructs. Table 6 confirms that each item possessed a stronger loading on its own construct; thus, discriminant validity was fulfilled. In addition, based on Henseler et al. [100], the heterotrait–monotrait ratio of correlations, better known as HTMT, is said to be an alternative to the Fornell and Larcker criterion for testing discriminant validity. The figures of HTMT should not exceed 0.9 to indicate that the two reflective constructs are discriminant, as shown in Table 7. In this study, all the constructs were discriminant.

Table 6. Discriminant validity matrix.

	1	2	3	4	5	6	7	8
Digital collaborative tools	0.764							
Environmental factors	0.442	0.719						
Interactivity	0.416	0.518	0.75					
Motivation	0.623	0.458	0.572	0.758				
Personal factors	0.492	0.514	0.505	0.622	0.716			
Social media support	0.421	0.348	0.27	0.492	0.352	0.739		
Student engagement	0.688	0.395	0.57	0.672	0.471	0.369	0.721	
Student participation	0.634	0.561	0.628	0.642	0.591	0.357	0.714	0.749

Table 7. HTMT matrix for discriminant validity.

	Digital Collaborative Tools	Environmental Factors	Interactivity	Motivation	Personal Factors	Social Media Support	Student Engagement
Environmental Factors	0.554						
Interactivity	0.579	0.784					
Motivation	0.731	0.572	0.788				
Personal factors	0.637	0.731	0.767	0.803			
Social media support	0.529	0.443	0.393	0.614	0.492		
Student engagement	0.797	0.456	0.809	0.781	0.603	0.464	
Student participation	0.71	0.654	0.836	0.713	0.75	0.431	0.803

4.2. Structural Model Evaluation

A structural model evaluation was conducted in order to determine whether the hypotheses of the study are supported by the data attained from the analysis. Figure 3 depicts the structural model that was derived from SmartPLS 3 after conducting a non-parametric bootstrapping with a sample of 5000. The coefficient of determination (R^2) values for this were 0.611 and 0.509, which fall under the moderate category. This means that 61.1% of the total variance in student engagement was explained by personal factors, environmental factors, social media support, interactivity, digital collaborative tools, and motivation. Additionally, 50.9% of the total variance in student participation was explained by student engagement.

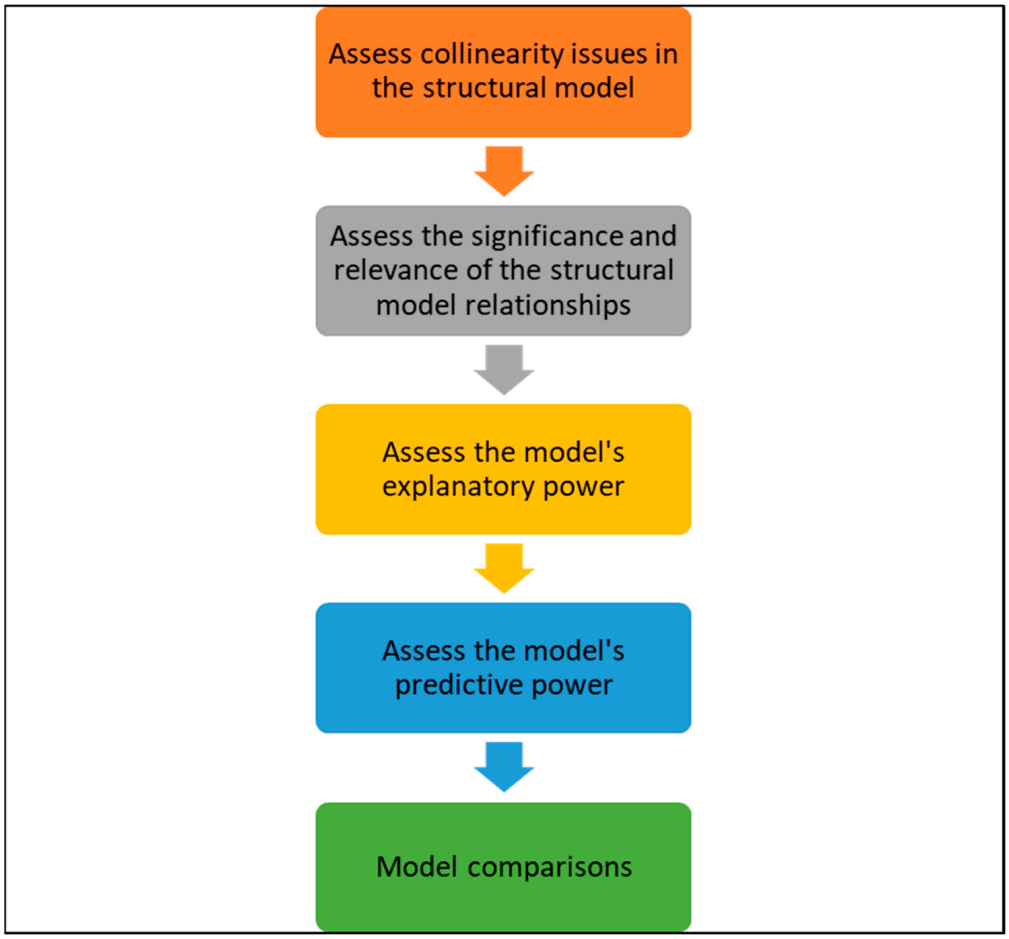

Figure 3. Steps in assessing structural models.

Based on Hair et al. [101], assessment of a structural model was conducted as per the steps in Figure 3 below. First, the model had to be assessed for potential collinearity issues.

The rationale for this is that ordinary least squares (OLS) regressions of each endogenous construct on its corresponding predictor constructs are used to estimate path coefficients in structural models. The collinearity analysis is outlined in Table 8 below, wherein the variance inflation factor (VIF) values were below 3, therefore indicating that the constructs had no multicollinearity issues.

Table 8. Collinearity analysis.

Constructs	Variance Inflation Factor (VIF)
Digital collaborative tools	1.774
Environmental factors	1.637
Interactivity	1.736
Motivation	2.059
Personal factors	1.883
Social media support	1.388
Student engagement	1.000

The structural model illustrated in Figure 4 indicates the significance of the path coefficients and relevance of the path coefficients. According to Streukens and Leroi-Werelds [102], the significance of the assessment builds on bootstrapping standard errors as a basis for calculating *t*-values of path coefficients or, alternatively, confidence intervals, which is an equivalent to the assessment of formative indicator weights. If the value of zero does not lie within the 95% confidence range, then the path coefficient is significant at the 5% level. Path coefficients are normally between 1 and +1 in terms of relevance, with coefficients near 1 indicating strong negative correlations and those near +1 showing strong positive relationships. It is worth noting that values below 1 and above +1 are theoretically possible—for example, when collinearity is extremely high. The path coefficients show how changes in an endogenous construct's values are linked to changes in a predictor construct's standard deviation unit while keeping all other predictor constructs constant. Hence, in this study the path coefficients as explained in Table 9 were derived for the relationships between constructs. Digital collaborative tools, interactivity, and motivation towards student engagement showed strong positive correlations of values within the range. The same results apply for the relationships between the constructs of student engagement and student participation, which also indicated a very strong positive correlation. However, there was indication of strong negative correlations between the constructs of personal factors, environmental factors, and social media support and student engagement, where the values indicated did not fall within the stipulated regions. The beta coefficients, also known as beta values, are estimations of the parameters of the straight-line equation that a dataset is based on. The absolute value of the correlation coefficient indicates how well the points in the data set are aligned. The coefficient's sign specifies whether the fitted line's slope is positive or negative [103]. Figure 4 indicates these values and their significance in the analysis.

According to Hair et al. [101], the subsequent step is to investigate the endogenous construct's coefficient of determination (R^2). R^2 is a measure of the model's explanatory ability and represents the variation explained in each of the endogenous constructs. Based on Rigdon [104], R^2 is a measure of the model's explanatory ability and represents the variation explained in each of the endogenous constructs, which is also known as the in-sample predictive power. According to Sharma et al. [105], a different sample selected from the same population would most likely not fit the same model. When a concept that is inherently predictable, such as physical processes, is measured, R^2 values of up to 0.90 might be reasonable. Nevertheless, based on Hair et al. [101], comparable R^2 value levels in a model that forecasts human attitudes, perceptions, and intentions would possibly specify model overfit. In this study, R^2 for student engagement was 0.611 and student participation indicated an 0. R^2 value of 0.509, which indicates acceptable model fit. Prior studies in social sciences and similar areas of research indicated that values between 0.5

and 0.7 is common for the R^2. When additional explanatory variables are added to a model, R^2 tends to increase. The modified R^2 metric adjusts the R^2 value based on the number of explanatory factors in relation to the data size, and is considered a more cautious estimate of R^2 [106]. However, the adjusted R^2 is not an accurate measure of an endogenous construct's explained variance because of the correction factor used to account for data and model size [107].

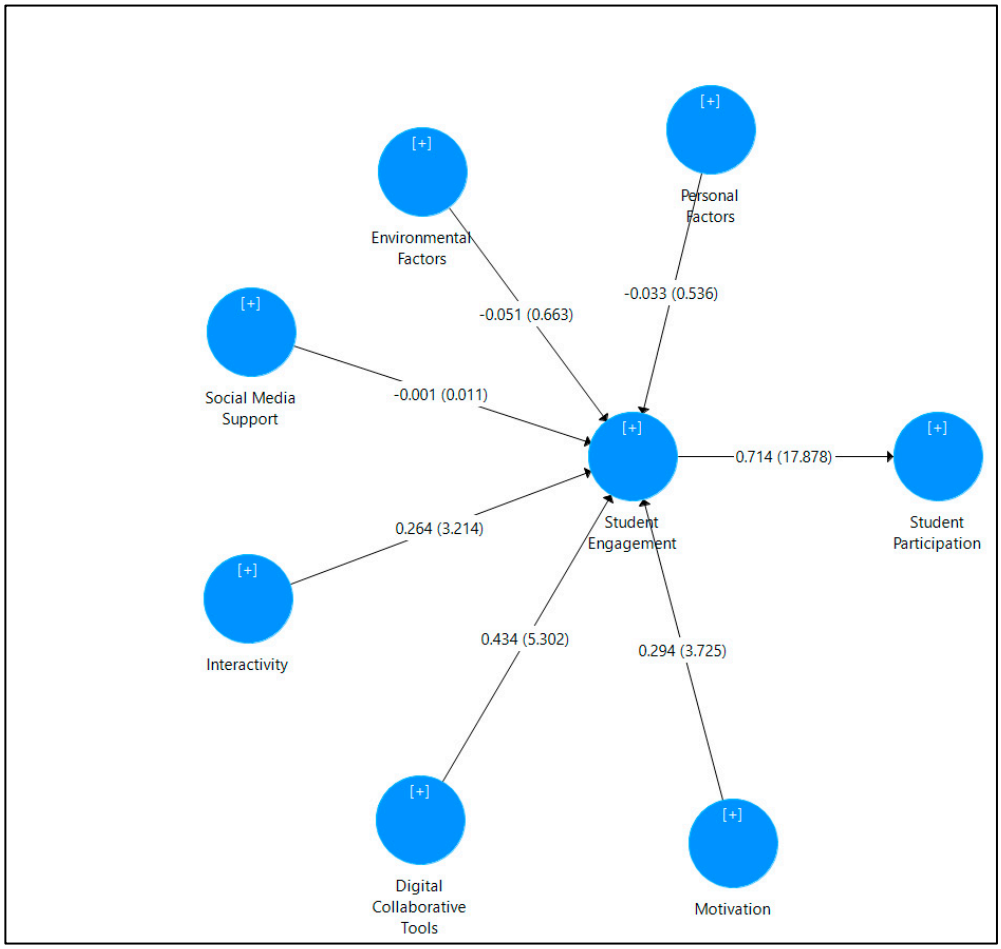

Figure 4. The results of the structural model, path coefficients (*t*-values).

Table 9. R^2 and Q^2 values.

	R^2	Q^2
Student engagement	0.611	0.285
Student participation	0.509	0.262

The predictive significance of a model is measured by the Q^2, whereby if the indicative values are above 0 it is deemed to be good. Q^2 also establishes the endogenous components' predictive value. Q^2 values greater than zero indicate that the data have been well reconstructed and that the model is predictive. Hence, a Q^2 greater than 0 indicates that the model is predictive. In this research, Q^2 values for both student engagement and student participation were above zero, which indicates that there was predictive relevance in both the constructs. Both R^2 and Q^2 values are illustrated in Table 9 below.

Table 10 depicts the path coefficient for this study. In order for the beta value to make an impact on the research model, its value had to be at least 0.1, whereas the t-statistic value had to be greater than 1.645. Based on Table 10, digital collaborative tools, interactivity, and motivation had a significant positive influence on student engagement. Student

engagement had a significant positive influence on student participation as well. However, environmental factors, personal factors and social media support did not have a significant positive influence on student participation.

Table 10. Beta value, t-statistic, *p*-value, and hypothesis decision.

Hypothesis	Constructs	Beta	T-Statistic	*p*-Value	Decision
H_1	Personal factors -> student engagement	−0.033	0.536	0.592	Not Supported
H_2	Environmental factors -> student engagement	−0.051	0.663	0.508	Not Supported
H_3	Social media support -> student engagement	−0.001	0.011	0.991	Not Supported
H_4	Interactivity -> student engagement	0.264	3.214	0.001	Supported
H_5	Digital collaborative tools -> student engagement	0.434	5.302	0.000	Supported
H_6	Motivation -> student engagement	0.294	3.725	0.000	Supported
H_7	Student engagement -> enhanced student participation	0.714	17.878	0.000	Supported

5. Discussion

The study showed that digital collaboration tools, interactivity, motivation, and student engagement were supported; however, environmental factors, personal factors, and social media support were not supported. Personal factors, according to Bandyopadhyay and Bandyopadhyay [66], are defined as a particular background of an individual's life and the feeling that can impact functioning positively or negatively. In the context of our model, we did not find any relationship between this construct and student engagement. This implies that prior experience in a student's life may not impact their participation in online collaborative sessions. This is probably given the fact that our assumption was that our respondents had access to technology and broadband, and were familiar with online teaching and learning. Issues such as family background—e.g., income levels and economic status—did not matter. As such, the findings are consistent with our assumption in this regard.

Environmental forces, namely, the external learning environment, which dramatically affects the learning outcomes of students, such as space, comfort, communication, noise levels, etc., as defined by Marek and Wu [67], did not impact student engagement. Like personal factors, this construct did not make any impact, given the respondent's prior experience of being in an online world over a prolonged period. We would argue that they would have become familiar with creating a conducive learning environment, and as such it can be classified as a hygiene factor in online learning.

The third construct that was not supported was social media support—defined as the use of social media in supporting teaching and learning [68]. Although this is a key factor in harnessing student engagement, our findings suggest it was not consistent with prior work. This, we argue, is given that the faculty members involved in delivering online classes did not make use of extended application and social media tools and support. Essentially, we found that only basic platforms such as Google Classrooms and Meet were used, without additional support from social media.

Interactivity is the extent to which an educator expects communication from students while teaching [69]. This construct in our study was supported and was significant in enhancing student engagement and participation therein. To foster collaborative learning, a key process for instructors is to ensure students are encouraged to communicate during sessions. The instructor in our institution/study did encourage continuous discussions and communication during online lessons, and this suggests positive collaboration.

Our findings suggests that the use of digital collaborative tools supports student engagement. Digital collaborative tools are defined as tools or platforms to aid the practice of people working together online or remotely [70]. Tools such as Padlet, electronic white

boards, Slido, and Kahoot are simple and quick-to-use digital collaborative tools that can be used to enhance student engagement. This was shown in our findings as well, and is consistent with prior work and studies [66,68].

Motivation was also found to support student engagement in collaborative learning in the online world. Svinicki and Vogler [71] defined motivation as the reasons for doing something or the level of desire to do something. The COVID-19 pandemic hit Malaysian shores more than 24 months ago. Universities, schools, and students were forced to pivot towards online learning. Our study suggests that with proper infrastructure and access to technology and with proper guidance, student motivation to engage with online learning and collaboration can be achieved. This could also be given the fact that students were very quick and ready to acclimatize towards new forms of learning and were motivated to do so.

Finally, consistent with the theory, our study suggests that when students are engaged with online learning, they generally participate more in collaborative efforts. Vonderwell and Zachariah [72] defined student participation as taking part and joining in a dialogue for engaged and active learning in online classes. Typically, when students engage well with peers and instructors in the online environment, they can excel in collaborative efforts. Table 11 depicts a summary of the results for this study.

Higher education institutions have been the epicenter of knowledge generation and dissemination for millennia. Access to information and knowledge, however, is no longer restricted to the physical location of educational institutions. Rather, information and knowledge about a wide range of subjects may be obtained through a variety of platforms, including open-source databases and web browsers, applications, and encyclopedias, all of which allow users to expand their knowledge. Despite its challenges, this new trend should be viewed as an opportunity rather than a danger to higher education institutions. Students like to work on projects with their classmates and learn concepts on days like during and post COVID-19.

Hence, during collaboration, they prefer to reinterpret ideas, defend their perspectives, articulate issues, and get a deeper understanding. Collaborative learning, also known as active learning, is a method that involves students questioning, learning from, and probing one another. Given the current situation, which includes more and more distance and remote learning opportunities, collaborative technology can help keep students engaged in the same way they are on campus. Furthermore, to enable innovative management at the institutional level, it is important to develop and apply integrated digital instructional technologies. In terms of the learning environment, it is critical to have informal learning and functional research areas that are fully digitally equipped.

Students are accustomed to using interactive technology in their daily lives and anticipate the same in school. Thus, to encourage cooperation and provide students with an exceptional learning experience, institutions can use digital whiteboard tools, on-demand and pre-planned sessions, applications, and desktop sharing. Students can easily annotate and share ideas both in and out of the classroom with various technology-assisted tools. Universities and higher learning institutions need to embark on redesigning the learning spaces for digital collaborative learning, thus creating a digital teaching and learning policy that expresses support for high-quality education, the development of the academic community's digital skills, the promotion of innovation in the institution, and the establishment of a framework for the issuance of certified digital qualifications and the validation of acquired digital skills that are dependable, multilingual, and can be stored in professional profiles. It is becoming necessary to change the widely used instructional approaches. Hence, to keep up with the quick rate of change in the world, traditional teaching techniques in Malaysian higher education institutions must be replaced with new ones that improve students' digital skills and competencies, as well as their flexibility of thought.

Table 11. Summary of the literature review.

Research Questions	Research Objectives	Analysis	Conclusion
What is the relationship between personal factors and student engagement towards enhanced student participation?	To investigate the relationship between personal factors and student engagement towards enhanced student participation.	The study revealed that there was no significant relationship between personal factors and student engagement towards enhanced student participation.	The research question has been answered and the objective has been met.
What is the relationship between environmental factors and student engagement towards enhanced student participation?	To investigate the relationship between environmental factors and student engagement towards enhanced student participation.	The study revealed that there was no significant relationship between environmental factors and student engagement towards enhanced student participation.	The research question has been answered and the objective has been met.
What is the relationship between social media support and student engagement towards enhanced student participation?	To investigate the relationship between social media support and student engagement towards enhanced student participation.	The study revealed that there was no significant relationship between social media support and student engagement towards enhanced student participation.	The research question has been answered and the objective has been met.
What is the relationship between interactivity and student engagement towards enhanced student participation?	To investigate the relationship between interactivity and student engagement towards enhanced student participation.	The study revealed that there was a significant positive relationship between interactivity and student engagement towards enhanced student participation.	The research question has been answered and the objective has been met.
What is the relationship between digital collaborative tools and student engagement towards enhanced student participation?	To investigate the relationship between digital collaborative tools and student engagement towards enhanced student participation.	The study revealed that there was a significant positive relationship between digital collaborative tools and student engagement towards enhanced student participation.	The research question has been answered and the objective has been met.
What is the relationship between motivation and student engagement towards enhanced student participation?	To investigate the relationship between motivation and student engagement towards enhanced student participation.	The study revealed that there was a significant positive relationship between motivation and student engagement towards enhanced student participation.	The research question has been answered and the objective has been met.
What is the relationship of student engagement towards enhanced student participation?	To investigate the relationship of student engagement towards enhanced student participation.	The study revealed that there was a significant positive relationship of student engagement towards enhanced student participation.	The research question has been answered and the objective has been met.

6. Conclusions

The study concluded that digital collaboration is significant for student participation and its application indirectly aids students to perform better in and out of classroom settings, especially during the COVID-19 pandemic movement restrictions. Digital collaboration ensures that no one in the teaching and learning process misses out on knowledge sharing and knowledge retention even though they are participating remotely. Social interactions are also maintained with the presence of digital collaboration, something that educators were worried about when teaching and learning switched from traditional face-to-face lessons to online lessons. This trend is expected to continue in the next couple of years, as it is important as a new norm of learning.

Limitations and Future Research Directions

The quick transformation of families into classrooms where there was little technical support and not-so-seamless connectivity, clearly "threw teachers and children into the water." This digital journey is a lengthy one that has yet to be completed. Even though the data we examined revealed intriguing insights on digital collaboration and answered our research questions, there are several constraints to be aware of. First and foremost, our research is exploratory and is based on a limited number of responses from a small number of people. Furthermore, approximately 86% of the respondents were undergraduate students, and this limits our research in some ways because postgraduate students may have different perspectives on the matter. Additionally, the respondents for this study had access to technological resources such as the Internet, computers, and mobile devices. This may not be the case for students in Malaysia and other countries who may have limited access to such resources. These limitations can be addressed in future research. Researchers may opt to conduct a study that focuses on the availability of technological resources and its effect on participation in digital collaboration during COVID-19. Further studies may also look into adopting and incorporating new or additional variables pertaining to digital collaboration using other learning theories. Findings from these studies would hopefully assist higher learning institutions to improve their adoption of digital technologies in teaching and learning processes, especially since online learning has become one of the most important methods of learning due to the pandemic.

To summarize, the goal of this study was to determine how digital collaboration affects student engagement and participation during and after COVID-19. Based on the quantitative analysis of students' input on how institutions can prepare and transform to adopt an integrated digital approach, it can be concluded that Malaysian higher learning institutions must take significant steps toward implementing digital collaboration and digital transformation, while also being aware of the hidden implications. Digital collaboration should affect areas and stakeholders other than the academic community in the future (board members, teachers and researchers, undergraduates, postgraduates, alumni, potential future students, administrative staff). However, on a side note, digital collaboration can be used to examine the government and public institutions, civil society, and the commercial sector, as well as its impact on them.

7. Ethics Approval

The Research Ethics Committee (REC) of Multimedia University granted an ethics approval for this research. The approval number is EA0232022.

Author Contributions: Conceptualization, S.G.; methodology, S.G., A.H.K., and M.R.; validation, S.G., and M.R.; formal analysis, S.G. and A.H.K.; investigation, S.G., A.H.K., and S.V.; resources, S.G., A.H.K., and S.V.; data curation, A.H.K.; writing—original draft preparation, S.G., A.H.K., and S.V.; writing—review and editing, S.G. and M.R.; supervision, S.G. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement: The study was conducted in accordance with Malaysia's Personal Data Protection Act 2010 and approved by the Research Ethic Committee (REC) of Multimedia University (approval number EA0232022).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data attained from the questionnaire for this study are available at https://doi.org/10.6084/m9.figshare.19501357 (accessed on 2 April 2022). This file can be opened in Microsoft Excel and SPSS.

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Conflicts of Interest: The authors declare no conflict of interest.

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