Comparing a United States-based and an International Academic Campus Students' Learning Experience Using Face-to-Face and Synchronous Modes: An Observation in Undergraduate Engineering Classes

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Abstract

The benefits and convenience of distance education were widely documented in academic journals and presented and discussed at several international gatherings and symposia; however, it did not become entirely a fully adopted approach until the COVID-19 pandemic spread globally. COVID-19 brought new challenges around the globe; however, its most significant challenge was ensuring students at all levels could continue their education, while educational institutions were shut down and face-to-face instruction came to a complete halt globally in the spring of 2020.

During the pandemic, a US based university with international campus located in the Middle East followed the recommended delivery methods that the university implemented in March 2020. This presentation reports the results of an empirical study conducted at these two campuses in two undergraduate courses that adopted distant learning methods. Further, this presentation compares the results of a survey conducted on both campuses to determine their differences. The survey was administered to students in remote in-class (synchronous) and face-to-face learning. A Chi-Square comparison of the results was conducted, and several conclusions were drawn that helped better understand the difference between these two modes of education.

Keywords

Online delivery methods; Face-to-face instruction, Effectiveness of online teaching; Remote teaching and learning ability; Synchronous instructions.

Introduction

Over the past 30 years, several countries located in the Persian Gulf area developed strategic plans, Vision 2023, to transform their fossil fuel-based economy into knowledge-based and to raise the standard of living of their citizens. Countries such as Saudi Arabia, Kuwait, the United Arab Emirates, International campus, and Bahrain have achieved significant milestones over the past three decades by investing in infrastructure and STEM education, attracting many petrochemical companies to seek joint ventures in these places [1]. Attracting the coming generation to pursue academic education in engineering and science has been one of the primary pillars of the "Vision 2030" in these countries, and the responsible government offices have significantly invested in building state-of-the-art facilities to attract Western academic institutions to seek joint ventures by establishing branch campuses in these countries ([2]-[6]). One of the smaller monarchies in the Persian Gulf, became one of the early adopters of this education philosophy by establishing an academic entity to attract highly regarded global

educational institutions to establish a branch campus in this location. in 1997, which was officially inaugurated on October 13th, 2003 [2]. This academic facility has since grown to be the home of eight highly ranked universities. One of these US-based academic institutions located in this facility formally started its operation in 2003, and its inaugural cohort received their engineering degrees in May 2008. Since its inception, this branch campus has offered undergraduate degrees in Chemical, Electrical, Mechanical, and Petroleum Engineering and graduated over 1,600 engineers in the above-referenced fields. The academic curricula for these programs are identical to those offered in the main campus and diplomas are also issued by the main campus.

Students from the host country historically make up over fifty percent of the enrollments, and the rest are non-citizen students whose parents or siblings reside in this host country and hold temporary residency permits to stay in the country. The campus faculty is comprised of faculty from the main campus in the United Stated who express the desire to temporally relocate to the Middle East or people with the Doctor of Philosophy (Ph.D.) degrees hired exclusively to provide instructional services at the location. All four engineering degree programs offered at this international location by the main campus have been ABET accredited degrees since 2008. The instructional language at this campus is English, and all admitted to engineering programs possess high proficiency in it.

The host country is a peninsula surrounded by the Persian Gulf and connected by land to the Kingdom of Saudi Arabia. The country's population in 2023 was estimated at about 3 million, and its natives make up about 15% of the total population. The rest are expatriates working for various entities in the country. As of 2022, this host country has the world's fifth-highest GDP per capita, according to the International Monetary Fund. Although Arabic is the official language in the country, a large percentage of the population is fluent in English. The country's Vision 2030 focuses on the capacity development of its population. It is one of the few nations in the world that has invested much in establishing some of the most significant standards of life ([1], [2], [6]-[8]).

Background

In March 2020, the arrival of the worldwide COVID-19 epidemic created a massive challenge for entities that were designed for public gatherings. Local and national governing bodies decided to stop its spread by closing all public places, including restaurants, schools, public transportation, places of worship, etc. Insufficient public knowledge about the virus and its enormous transmission rate ended the international community's operations and created public insecurity and a lack of belief that this unknown phenomenon can be controlled before it can take its massive toll on public health and the worldwide economy. As an alternative to in-person meetings, most entities, such as schools or places of worship, decided to use readily available technologies but publicly unknown to conduct their meetings. Mass communications systems such as Zoom, SKYPE, MS TEAMS, etc., started becoming household names for academic institutions. Most of these places elected to continue the Spring 2020 academic session by adopting and providing training to their staff and students. These systems are an alternative to face-to-face instructional techniques despite the fact that many of these tools have not been

thoroughly tested and their limitations have not been explored in the past. Furthermore, the reliability of existing internet systems and the shortcomings in the required speed to make these activities more meaningful created challenges with little or no short-term solutions. Unlike many Western nations, many Middle Eastern countries started using 5G speed communication technologies in 2018 [9]. The availability of a reliable high-speed internet system for instruction made the transition to these internet-based systems fast. These multimedia systems were used by the faculty, staff, and students throughout all US-based and international campuses, [10]. During the pandemic like many global campuses, both the US-based and international campuses of transitioned to entirely online learning using multimedia resources.

Data Collection

The study aimed to examine the reactions of students enrolled in two distinct courses in the United States and overseas. One course, ISEN 210: Introduction to Industrial and Systems Engineering Design, comprised two sections instructed by the same educator at the main campus in the United States, while the other course, PETE 325 Petroleum Production Systems, included two sections taught online by the same instructor at the international campus. The two segments of the course were delivered to the Middle East campus to students in the Petroleum Engineering Department, whereas those conducted in the US were for Industrial Engineering students. The poll conducted for students from both countries was identical. The study was conducted in the Spring 2021 semester [2].

The survey posed categorical questions to students regarding their experiences with enrolling in both in-person and online programs, their skill levels, fundamental demographics, the benefits and drawbacks of in-person compared to online education, remote access to course materials, and additional insights related to their perspectives on in-person versus online courses [2]. The Human Research Protection Program at the US campus evaluated and approved the survey.

The survey included categorical response options, necessitating statistical analysis to compare the two data sets (US-based campus vs. International campus). This involved calculating the Relative Frequency ratios and performing Chi-square ($\chi 2$) tests after determining the Expected Distribution and comparing it to the Actual Distribution.

Table 1 below presents a roster of students who engaged in the survey. This paper delineates the findings of an empirical investigation conducted with 225 students. Figure 1 illustrates the Relative Frequency Ratios for the surveyed students from each campus, categorized by gender.

Table 1. Students Participating in the Survey

Campus	Male	Female	Total
US-based Campus	66	30	**96**
International Campus	78	51	**129**
Total	**144**	**81**	**225**

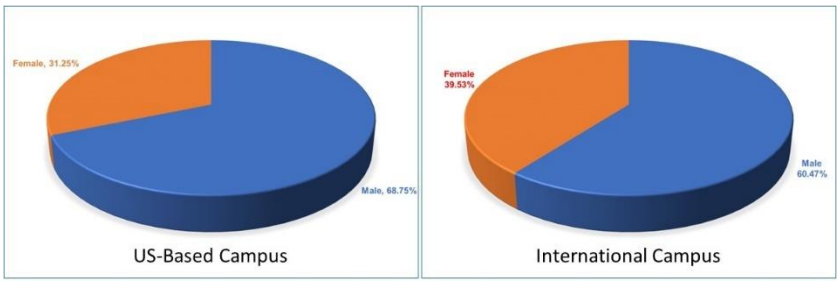

Figure 1. Relative Frequency Ratio by Gender

The students' perceptions of their own information technology skills are depicted in Figure 2. More than two-thirds of students on both campuses said they had a moderate level of information technology (IT) knowledge.

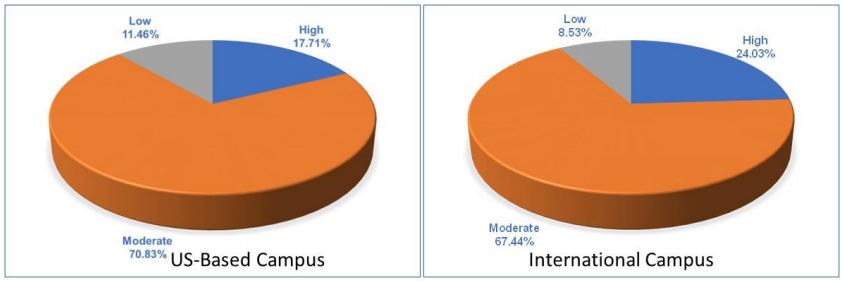

Figure 2. Students Level Information Technology (IT) Skills

Table 2 presents the students' perspectives on the benefits of engaging in a lesson remotely. Figure 3 illustrates the Relative Frequency Ratios of Students' Perceived Benefits of Engaging in Remote Classes. The data indicates that "Class Interactivity" ranked lowest, while "Access to Online Material" ranked highest at both schools.

Table 2. Advantages of Participating in a Class Remotely

Campus	Access to Online Materials	Learning on Your Own Pace	Ability to Stay at Home	Classes Interactivity	Ability to Record a Meeting	Comfortable Surrounding	Total
US-based Campus	71	58	71	7	62	56	**325**
International Campus	96	80	98	17	92	85	**468**
Total	**167**	**138**	**169**	**24**	**154**	**141**	**793**

Table 3 outlines the disadvantages that the students believe they face as a result of participating in a class remotely. Figure 4 depicts students' perceptions of these disadvantages and displays the relative frequency ratio of these perceptions. Nearly equal numbers of students from both campuses mentioned each of the disadvantages. The data indicates that "Lack of Interactions with Other Students" and "Reduced Interactions with the Teacher" ranked highest at both schools.

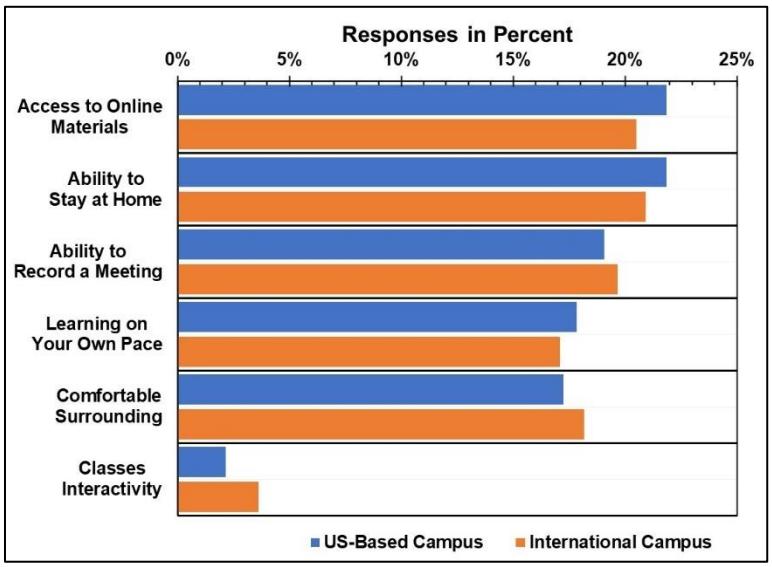

Figure 3. Relative Frequency Ratios by Students' Perceived Advantages of Participating in a Class Remotely

Table 3. Disadvantages of Participating in a Class Remotely

Campus	Reduced Interaction with the Teacher	Technical Problems	Lack of Interactions with other Students	Poor Learning Conditions at Home	Lack of Self-Discipline	Social Isolation	Total
US-based Campus	80	63	81	47	65	68	**404**
International Campus	101	92	100	56	72	84	**505**
Total	**181**	**155**	**181**	**103**	**137**	**152**	**909**

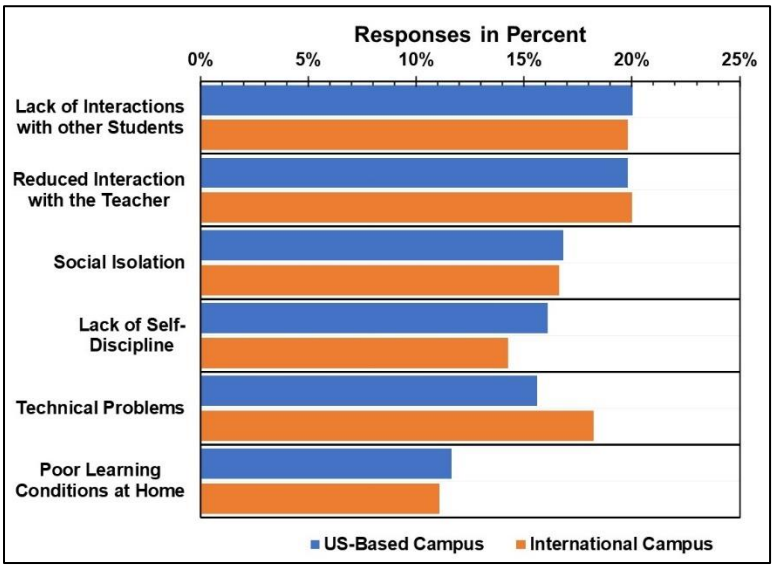

Figure 4. Relative Frequency Ratio of Students' Perceived Disadvantages of Participating in a Class Remotely

Table 4 depicts the students' reported logistical challenges when participating remotely in class. Figure 5 depicts the relative frequency ratio of students perceived logistical challenges when participating in a remote class. According to the findings, "Internet reliability" is the most perceived logistical difficulty at both campuses.

Table 4. Logistical Challenges of Participating in a Class Remotely

Campus	Quiet/Private Space to Study	Reliable Internet or Remote Connection	Printer/ Scanner	Webcam/ Camera	Computer/ Tablet	Total
US-based Campus	50	57	39	22	14	**182**
International Campus	66	74	50	32	19	**241**
Total	**116**	**131**	**131**	**54**	**33**	**423**

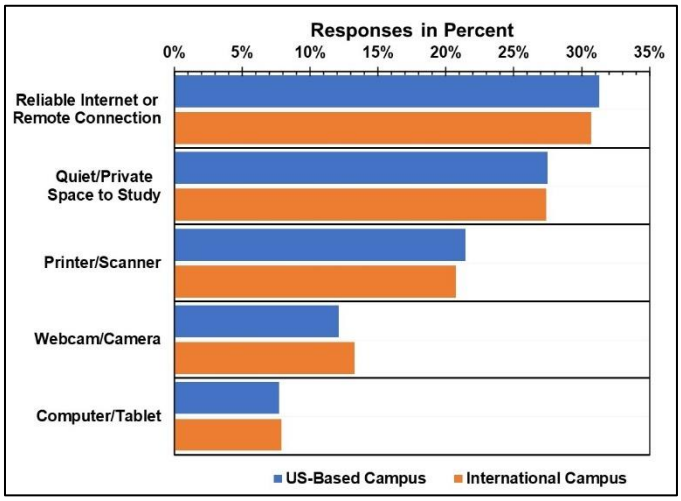

Figure 5. Relative Frequency Ratio of Students' Perceived Logistical Challenges of Participating in a Class Remotely

The students were then asked to compare face-to-face (f2f) learning versus remote class participation (synchronous learning) in terms of mastering learning objectives such as knowledge, practical skills, and social competencies. Table 5 demonstrates how students rated the usefulness of participating in class remotely in terms of theoretical knowledge increase. Figure 6 depicts the Relative Frequency Ratio of students' theoretical knowledge increase as a result of distance learning participation. The vast majority of students from both campuses believed that participating in distance learning was "Ineffective" in gaining theoretical knowledge. This was followed by a close group of students who believed it was effective.

Table 5. Ratings of the Effectiveness of Participating in Class Remotely in Terms of Increasing Knowledge Theoretically

Campus	Extremely Ineffective	Ineffective	No Difference	Effective	Extremely Effective	Total
US-based Campus	8	44	11	30	3	**96**
International Campus	9	49	20	42	9	**129**
Total	**17**	**93**	**31**	**72**	**12**	**225**

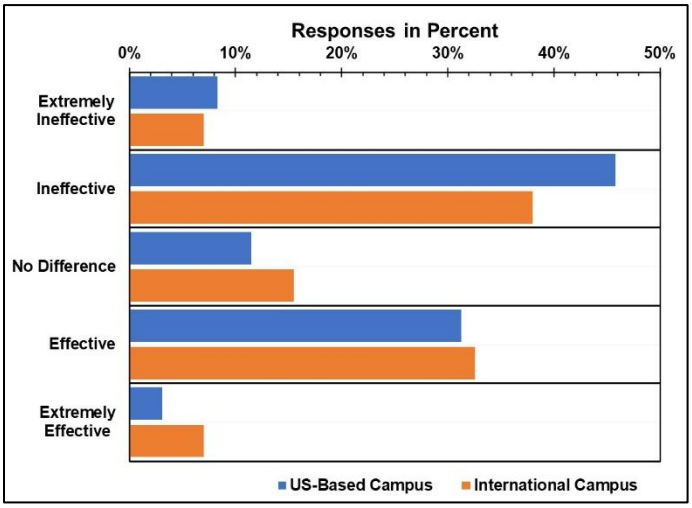

Figure 6. Relative Frequency Ratio of the Students' Students' Perceived Effectiveness of Participating in Distant Learning in Terms of Increasing Knowledge Theoretically

Table 6 demonstrates students' perceptions of the effectiveness of engaging in a face-to-face (f2f) class in terms of theoretical knowledge acquisition. Figure 7 depicts the Relative Frequency Ratio of students' efficacy of engaging in a face-to-face class in terms of theoretical knowledge acquisition. More students on both campuses stated that attending a face-to-face session was "Effective" in terms of information acquisition.

Table 6. Ratings of the Effectiveness of Participating in a Face-to-Face Class in Terms of Increasing Knowledge Theoretically

Campus	Extremely Ineffective	Ineffective	No Difference	Effective	Extremely Effective	Total
US-based Campus	2	7	14	60	13	**96**
International Campus	2	10	23	69	25	**129**
Total	**4**	**17**	**37**	**129**	**38**	**225**

Table 7 demonstrates how students rated the effectiveness of participating in class remotely in terms of improving practical/calculation skills. Figure 8 depicts the Relative Frequency Ratio of students' success in developing practical/calculation skills through distance learning. The vast majority of students on both campuses believed that distance learning was "Ineffective" in

improving practical/calculation skills. This was followed by a close group of students who believed it made no difference.

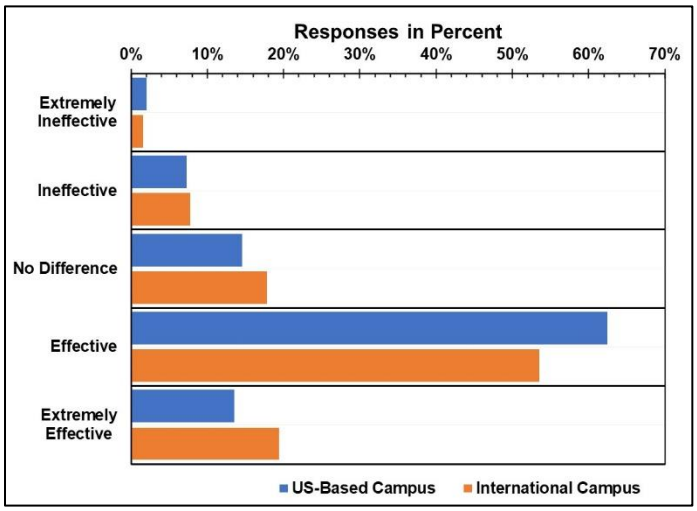

Figure 7. Relative Frequency Ratio of the Students' Students' Perceived Effectiveness of Participating in Face-to-Face Class in Terms of Increasing Knowledge Theoretically

Table 7. Ratings of the Effectiveness of Participating in Class Remotely in Terms of Increasing Practical/Calculation Skills

Campus	Extremely Ineffective	Ineffective	No Difference	Effective	Extremely Effective	Total
US-based Campus	16	32	27	18	3	**96**
International Campus	18	42	31	30	8	**129**
Total	**34**	**74**	**58**	**48**	**11**	**225**

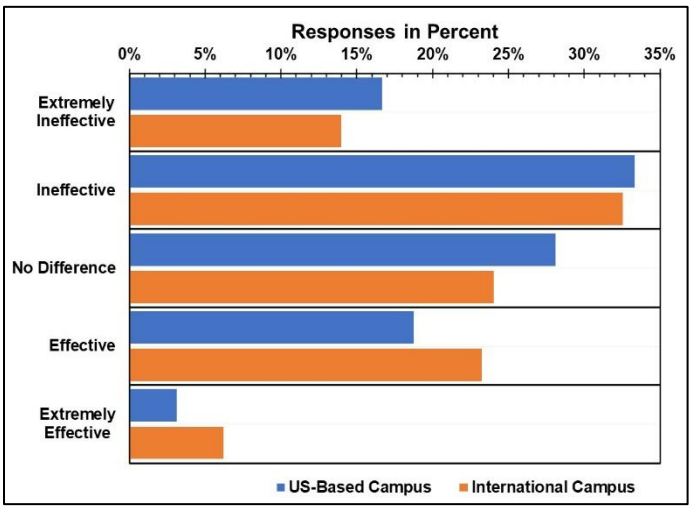

Figure 8. Relative Frequency Ratio of the Students' Students' Perceived Effectiveness of Participating in Distant Learning in Terms of Increasing Practical/Calculation Skills

Table 8 indicates how students rated the effectiveness of attending a face-to-face (f2f) lesson in terms of improving practical/calculation skills. Figure 9 depicts the Relative Frequency Ratio of students' efficacy of engaging in a face-to-face session in terms of improving practical/calculation skills. More students from both campuses said that taking a face-to-face lesson was "Effective" in improving practical abilities. This was followed by the phrase "Extremely Effective."

Table 8. Ratings of the Effectiveness of Participating in a Face-to-Face Class in Terms of Increasing Practical/Calculation Skills

Campus	Extremely Ineffective	Ineffective	No Difference	Effective	Extremely Effective	Total
US-based Campus	1	4	18	47	26	**96**
International Campus	1	6	26	58	38	**129**
Total	**2**	**10**	**44**	**105**	**64**	**225**

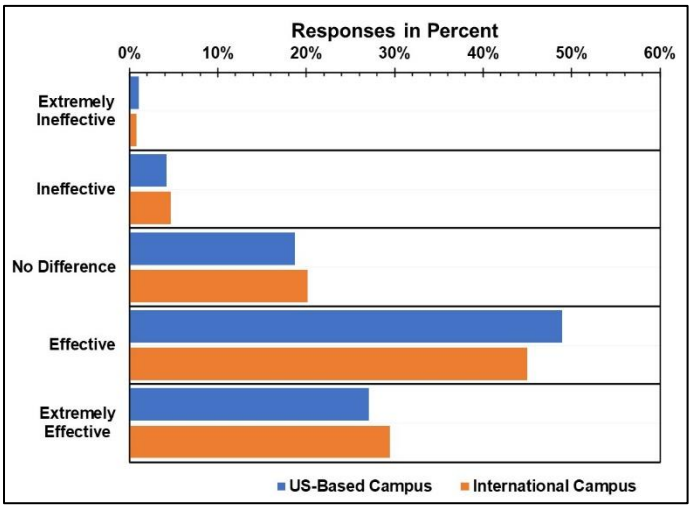

Figure 9. Relative Frequency Ratio of the Students' Students' Perceived Effectiveness of Participating in Face-to-Face Class in Terms of Increasing Practical/Calculation Skills

Table 9 demonstrates how students rated the effectiveness of participating in class remotely in terms of improving engineering lab abilities.

Table 9. Ratings of the Effectiveness of Participating in Class Remotely in Terms of Increasing Engineering Lab Skills

Campus	Extremely Ineffective	Ineffective	No Difference	Effective	Extremely Effective	Total
US-based Campus	52	34	4	5	1	**96**
International Campus	61	47	9	10	2	**129**
Total	**113**	**81**	**13**	**15**	**3**	**225**

Figure 10 depicts the Relative Frequency Ratio of students' efficacy in developing engineering lab skills through distance learning. More students on both campuses said that participation in distance learning was "Extremely Ineffective" in improving engineering lab abilities. This was followed by a close group of students who said it was "Ineffective."

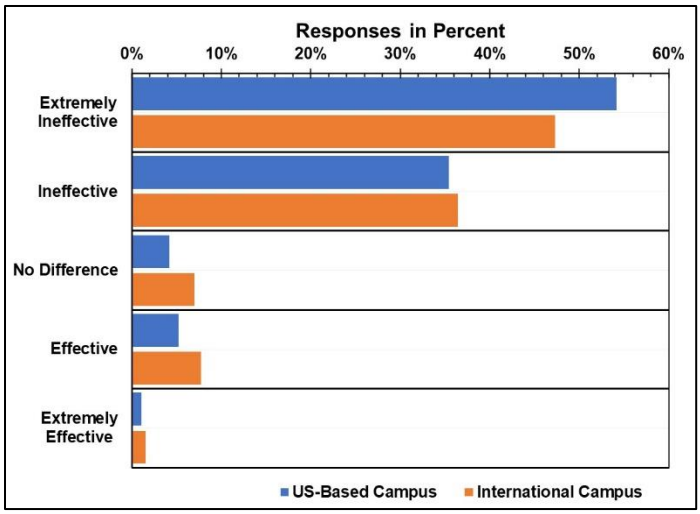

Figure 10. Relative Frequency Ratio of the Students' Students' Perceived Effectiveness of Participating in Distant Learning in Terms of Increasing Engineering Lab Skills

Table 10 demonstrates how students rated the effectiveness of attending a face-to-face (f2f) session in terms of improving engineering lab abilities. Figure 11 depicts the Relative Frequency Ratio of students' effectiveness in attending a face-to-face session in terms of improving engineering lab abilities. The majority of students on both campuses said that attending a face-to-face session was either "Extremely Effective" or "Effective" in improving engineering lab skills.

Table 10. Ratings of the Effectiveness of Participating in a Face-to-Face Class in Terms of Increasing Engineering Lab Skills

Campus	Extremely Ineffective	Ineffective	No Difference	Effective	Extremely Effective	Total
US-based Campus	4	3	3	31	55	**96**
International Campus	4	5	7	41	72	**129**
Total	**8**	**8**	**10**	**72**	**127**	**225**

Table 11 demonstrates how students rated the usefulness of participating in class remotely in terms of improving communication skills. Figure 12 depicts the Relative Frequency Ratio of students' efficacy in developing communication skills through distance learning. More students on both campuses stated that distance learning was "Extremely Ineffective" in improving communication skills. This was followed by a close group of students who said it was "Ineffective."

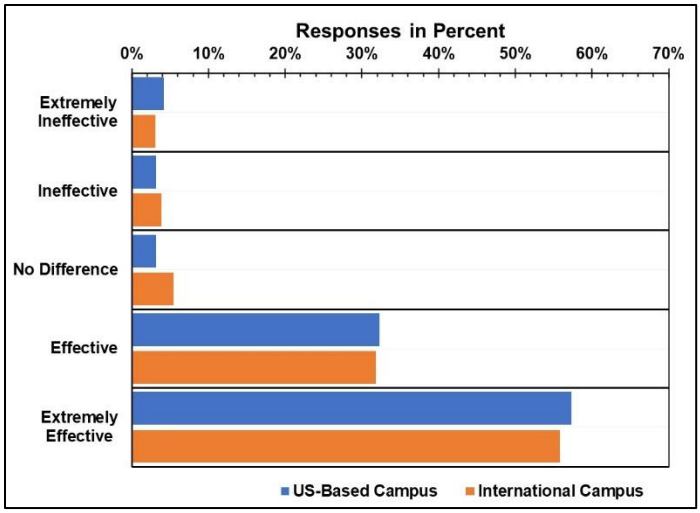

Figure 11. Relative Frequency Ratio of the Students' Students' Perceived Effectiveness of Participating in Face-to-Face Class in Terms of Increasing Engineering Lab Skills

Table 11. Ratings of the Effectiveness of Participating in Class Remotely in Terms of Increasing Communication Skills

Campus	Extremely Ineffective	Ineffective	No Difference	Effective	Extremely Effective	Total
US-based Campus	39	28	15	11	3	**96**
International Campus	43	38	22	20	6	**129**
Total	**82**	**66**	**37**	**31**	**9**	**225**

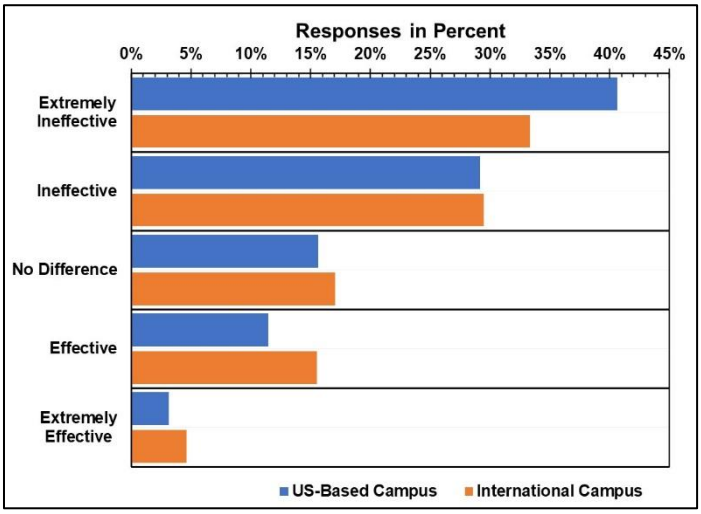

Figure 12. Relative Frequency Ratio of the Students' Students' Perceived Effectiveness of Participating in Distant Learning in Terms of Increasing Communication Skills

Table 12 displays the students' perceptions of the usefulness of attending a face-to-face (f2f) class in terms of improving communication skills. Figure 13 depicts the Relative Frequency Ratio of students' efficacy in improving communication skills through face-to-face class

participation. The majority of students on both campuses thought that taking a face-to-face lesson was either "Extremely Effective" or "Effective" in improving communication skills.

Table 12. Ratings of the Effectiveness of Participating in a Face-to-Face Class in Terms of Increasing Communication Skills

Campus	Extremely Ineffective	Ineffective	No Difference	Effective	Extremely Effective	Total
US-based Campus	4	4	9	38	41	**96**
International Campus	4	6	20	44	55	**129**
Total	**8**	**10**	**29**	**82**	**96**	**225**

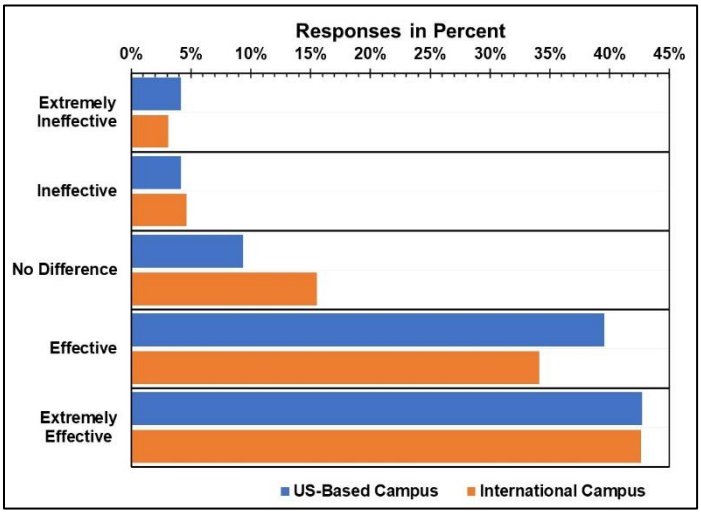

Figure 13. Relative Frequency Ratio of the Students' Students' Perceived Effectiveness of Participating in Face-to-Face Class in Terms of Increasing Communication Skills

A Pearson Chi-Square analysis was undertaken to assess the disparity between the observed and expected frequencies of outcomes in the categorical data from the two campuses. A p-value of less than 0.05 was employed to ascertain whether a significant difference exists between the two campuses. Table 13 presents the findings of this investigation.

Table 13. Chi-Square analysis

Data, and (possible responses)	Pearson Chi-Square *p*-values
Gender (Male or Female)	0.20
Student Classification (Freshman, Sophomore, Junior, Senior)	0.57
IT Skills (High, Moderate, Low)	0.57
Participated in any type of synchronous learning before the pandemic? (Yes, No)	0.53
Advantages of participating in class remotely (synchronous learning)? (Access to online materials, Learning on your own pace, Ability to stay at home, Classes interactivity, Ability to record a meeting, Comfortable surrounding)	0.88
Disadvantages of participating in class remotely (synchronous learning)? (Reduced interaction with the teacher, Technical problems, Lack of interactions with other students, Poor learning conditions at home, Lack of self-discipline, Social isolation)	0.92
Logistical challenges of participating in class remotely from your perspectives (Quiet/Private space to study, Reliable internet or remote connection, Printer/Scanner, Webcam/Camera, Computer/tablet)	0.99
Using a five-point scale, rate the effectiveness of participating in class remotely in terms of increasing knowledge theoretically (Extremely ineffective, Ineffective, No-difference, Effective, Extremely effective).	0.53
Using a five-point scale, rate the effectiveness of participating in class remotely in terms of increasing practical/calculation skills (Extremely ineffective, Ineffective, No-difference, Effective, Extremely effective).	0.69
Using a five-point scale, rate the effectiveness of participating in class remotely in terms of increasing engineering laboratories skills (Extremely ineffective, Ineffective, No-difference, Effective, Extremely effective).	0.75
Using a five-point scale, rate the effectiveness of participating in class remotely in terms of increasing communication skills (Extremely ineffective, Ineffective, No-difference, Effective, Extremely effective).	0.76
Using a five-point scale, rate the effectiveness of traditional face-to-face learning in terms of increasing knowledge theoretically (Extremely ineffective, Ineffective, No-difference, Effective, Extremely effective).	0.67
Using a five-point scale, rate the effectiveness of traditional face-to-face learning in terms of increasing practical/calculation skills (Extremely ineffective, Ineffective, No-difference, Effective, Extremely effective).	0.98
Using a five-point scale, rate the effectiveness of traditional face-to-face learning in terms of increasing engineering laboratories skills (Extremely ineffective, Ineffective, No-difference, Effective, Extremely effective).	0.92
Using a five-point scale, rate the effectiveness of traditional face-to-face learning in terms of increasing communication skills (Extremely ineffective, Ineffective, No-difference, Effective, Extremely effective).	0.69

Analysis and Discussions

The data presented indicates that student answers from both campuses were highly comparable. The research indicated that, despite the advantages of online learning, engagement in traditional face-to-face education appears to foster superior skills and interaction. The disadvantages of remote participation in synchronous learning highlighted "diminished interaction with the instructor" as the primary issue. Despite advancements in internet connectivity in the

international campus, characterized by superior Wi-Fi technologies, the data indicated logistical challenges related to participation in remote classes. Furthermore, students identified the lack of quiet/private study places as the second most significant logistical challenge.

Students were requested to evaluate the effectiveness of remote class participation (synchronous learning) on the enhancement of theoretical knowledge. The results indicated that distant classes were either highly ineffective or useless for acquiring theoretical knowledge. Students were requested to evaluate the efficacy of traditional face-to-face learning in enhancing their theoretical knowledge. The survey results indicated that students perceived conventional face-to-face instruction as "extremely effective" or "effective" in acquiring theoretical knowledge. The survey results indicated that students perceived remote learning as useless or very unsuccessful in enhancing their practical and calculation skills. The survey findings indicating students' evaluations of how conventional face-to-face learning enhanced their practical and calculation skills revealed that this teaching method was either highly successful or effective.

Online instruction inherently restricts students' capacity to perform practical experiments in technical laboratories. The laboratory experience is inherently irreplaceable by any alternative course delivery technique. Consequently, students at both campuses encountered a subpar experience in remote classes regarding laboratory instruction. Online classes were either highly ineffective or useless in enhancing students' engineering laboratory skills. In contrast, students evaluate the efficacy of conventional in-person learning for the enhancement of engineering laboratory skills as either extremely effective or effective. Students similarly perceived participation in a traditional classroom as either effective or highly effective in enhancing their communication abilities. This outcome was directly contrary to their reaction about remote learning, where they perceived online education as either highly ineffective or inefficient in enhancing communication skills.

The Chi-Square test ($\chi 2$) was employed to determine the relationship or independence between the two categorical variables (the two campuses). The observed data was compared to the expected data to assess major differences. A p-value of <0.05 was employed to assess the significance of differences between the two campuses across all survey questions when comparing the two datasets. The statistics indicated that there were no significant differences in the survey replies across the two campuses. This indicates that we are 95% positive that students from both schools had comparable responses.

Study's Limitation and Recommendations

This study was primarily based on the responses provided to a questionnaire designed to collect students' feedback concerning their learning challenges on two campuses during COVID pandemic. The assessment results purely reported students' perception and direct assessment due to restrictions imposed by the local government that oversee the international campus operations. Although most of the academic institutions in the US imposed the same restrictions for a limited period, certain countries including the aforementioned campuses implemented more stringent requirements due to the unknown nature of the pandemic virus causing the epidemy. All students enrolled in classes offered at the international campus were residents of the country, however,

several students expressed concerns about their learning progress which was halted due to the unavailability of a suitable learning environment at home. Although the same issue was raised by the US based students but with less severity.

While the pandemic was an extreme situation, it did open the door for more distant learning opportunities. These options lend themselves very well to some courses, but not all. In Engineering education, distant learning may not work very well for courses that require hands-on practice such as lab courses. However, one cannot deny the conveniences distant learning education has to offer. Therefore, it is always recommended to weigh the good and the bad that comes along with it to make educated decisions based on these variables and be able to balance between these conveniences and student education.

Conclusion

Reviewing students' responses on the international campus indicated that having access to more reliable internet systems with higher speed played an important role in the remote or synchronous learning and resulted in conducting more effective sessions. The availability of a reliable information technology system clearly facilitated students' communication with the course instructor and provided a better opportunity to students in working among themselves. However, the questionnaire did not pose any questions regarding this issue as the uploading, and the downloading speed of the network was not under the control of either the academic institution or course instructors. The responses also showed a higher percentage of students were in favor of face-to-face instructions and having access to course instructors for theoretical courses were preferred as they could speed up the learning process. Although both courses were primarily lecture-oriented with limited team project assignments, it became evident that offering online classes that required laboratory or team projects could have been less attractive to students who participated in this study.

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