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The Effectiveness and Potential of E-Learning in War Zones: An Empirical Comparison of Face-to-Face and Online Education in Saudi Arabia

KHAIRAN D. RAJAB¹, (Member, IEEE)

College of Computer Science and Information System, Najran University, Najran 55461, Saudi Arabia

e-mail: khairanr@gmail.com

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ABSTRACT This paper compares the effectiveness of e-learning and face-to-face education in the previously neglected context of Saudi Arabia. This is done by examining Najran University's e-learning experience after the institution suspended traditional course delivery due to the ongoing war between Saudi Arabia, the Arab Coalition, and Yemeni rebel groups. The analysis also considers the potential benefits offered by e-learning in crisis zones such as the southern border region of Najran, Saudi Arabia. The results indicate that there is no statistical or practical difference between online and face-to-face learning with respect to student performance. This paper also demonstrated that e-learning is capable of delivering the educational goals of higher learning institutions to areas wrecked by wars. E-Learning offers students a safe learning environment, engaging platforms, and most importantly a quality education. The findings of this paper contribute to a growing body of scholarship on the effectiveness and implementation of e-learning in the Middle East.

INDEX TERMS Education in war zones, e-learning, evaluation of face-to-face education, information communications technologies (ICTs), online education, Saudi Arabia.

I. INTRODUCTION

The government of Saudi Arabia has increasingly coalesced its efforts at implementing e-learning initiatives and programs into the kingdoms' higher education system since April 2016, when the Council of Ministers endorsed the 2030 vision to "expand the scope of online education" in the country. Albalawi [1] noted that the Saudi higher education system was gradually shifting from a traditional face-to-face classroom setting into a more web-based system. While the number of e-learning courses and programs has increased exponentially within Saudi universities, it is still unclear whether online learning is an effective educational model.

Research on the effectiveness of online education is both extensive and inconclusive [2]–[8]. On the one hand, many studies concluded that there is no statistical or practical difference between the academic outcomes of online and face-to-face courses [9]–[12]. On the other hand, many studies have found that student performance and satisfaction with online courses was better when compared to traditional face-to-face classes [13]–[16]. Additionally, few studies reported poor

student performance in online classes compared to traditional courses [16], [17].

Despite a large number of studies comparing student academic outcomes across various learning modes (such as face-to-face, hybrid, blended, and online or distance education), there has been no systematic evaluation of the effectiveness of e-learning in Saudi universities [18]–[22]. Previous studies on e-learning in Saudi Arabia focused on the types, breadth, future potential, and challenges of the mode [23]–[27]. Despite an interest in e-learning throughout the Kingdom, the effectiveness of it has not yet been adequately evaluated. Do online students perform the same, better, or worse than students who attend traditional classes in Saudi universities? This study attempts to address this question by comparing student performance in courses taught both online and face-to-face at the same public university in southern Saudi Arabia.

While scholarship on e-learning has extensively outlined the benefits of online education, it has failed to indicate that e-learning can be used as an effective educational delivery system in crisis areas [2], [5], [6], [12], [26]. E-learning expands the access of education to hard-to-reach groups, rural

populations, and female students in countries such as Saudi Arabia as well as among non-traditional groups including single parents, the less economically endowed, and the chronically ill [18], [25], [26]. The format also allows students to learn, develop, and enhance their technical skills by forcing them to utilize new educational tools [17], [27]. In addition to such advantages, this paper highlights the potential of e-learning in delivering intended educational outcomes within crisis zones.

This research contributes to ongoing debates concerning the effectiveness of e-learning in emerging educational systems such as in Saudi Arabia. Many policymakers have been hesitant in lending support for the expansion of e-learning, citing its ineffectiveness in delivering desired educational goals, unsuitability for students, lack of self-direction among students, regulation and motivation, institutional inexperience and inadequate technologies. Findings of this research clearly indicate that e-learning is an effective tool for achieving desired educational outcomes in countries where online education is still emerging, such as Saudi Arabia. It adds evidence to the nascent scholarship establishing a positive correlation between online education and better student outcomes in the Middle East. This study provides policymakers with a real success story demonstrating the effectiveness of e-learning in unconventional areas, with a predominantly conservative Arab constituency in Southern Saudi Arabia.

This research presents an efficient, accessible and timely solution to suspended higher education due to natural disasters, emergencies or civil wars. E-learning does not require students to travel to a brick and mortar structure where the lives of students are jeopardized due to air bombardments, rocket shelling, earthquakes or flooding. Students can access course materials remotely from a safe haven. Faculty can offer collaborative and assisted learning services to students using online platforms without worrying about their safety. E-learning provides a compelling educational solution that guarantees better equity and access to high quality education in emergency ridden areas around the world.

Distance education literature often neglects the connection between e-learning, its benefits and its application in unconventional contexts, such as war-zones. This research extends the study of e-learning by testing its effectiveness in war zones specifically. Evidence indicates that well-designed e-learning initiatives allow universities to provide equitable, high quality and efficient higher education to inaccessible populations such as those prevented from attending face-to-face courses due to wars or natural disasters. The concept of implementing e-learning in war-zones is inadequately investigated and needs to be developed further. This research expands the horizon for further rigorous analyses on the implementation of e-learning in natural disaster areas to address inadequate access to high quality education in those areas.

II. FACE-TO-FACE VERSUS ONLINE

Analyzing data from the same courses over a four-year period, Sussman and Dutter [28] compared student performance with respect to the medium of instruction, specifically face-to-face versus fully online courses. Using a post-test design, the authors concluded that the “data suggested that student learning outcomes were essentially the same for face-to-face and fully online delivery.” This finding seems to be pervasive in the literature comparing academic student outcomes across different means of instruction. Nevertheless, other studies found noticeable statistical and practical differences in student achievement based on the way that the courses were delivered [2], [7], [11], [14], [16], [29]. Therefore, the question remains whether online instruction delivers the same academic results as traditional face-to-face instruction. Despite the existence of hundreds of studies which attempt to answer this question, none have investigated it within the context of the Saudi educational system.

The seminal work ‘There is No Significant Difference Phenomenon’, [30] concluded that there is no statistical or practical difference in the student outcomes between alternative modes of educational delivery. Russell’s analysis included over three-hundred and fifty-five articles, reports, summaries, and related investigations which indicated no significant difference in the students’ academic and non-academic outcomes between face-to-face and distance education forms of delivery. Despite the criticisms Russell’s work has received regarding its lack of methodological rigor and inclusion criteria, a few meta-analyses on the effect educational delivery modes have on student academic and extracurricular outcomes found that no tangible difference exists between face-to-face and distance education delivery models such as hybrid, blended, or fully online. In a meta-analysis investigation examining the effects of traditional and distance education course delivery on student achievement, attitudes, and retention rates, utilizing one-hundred and fifty-seven studies, Hijazi, *et al.* [31] found a slightly positive difference, suggesting that distance education is actually more effective than face-to-face delivery in respect to student achievement. Nevertheless, there were no significant differences between the various educational delivery systems in respect to the student’s attitude toward the courses. Similarly, a meta-analysis conducted by Zhao, *et al.* [32] found no significant difference in student outcomes when comparing courses taught in traditional classroom settings and those taught in any form of distance education. In a more recent study, Dell, Low and Wilker compared student achievements in a human development graduate course and three educational psychology undergraduate courses taught both online and face-to-face at a large Midwestern United States university and concluded that the “results suggest there were no significant differences between the work submitted by students from the online sections and from the face-to-face students, and the methods of instruction are more important than the delivery platform” [33].

In a study comparing cyber and traditional learners' academic performance and perceptions on an introductory economics course, Navarro and Shoemaker [34] found that the online learners performed as well as or better than the traditional students with respect to their academic performance after holding the effects of gender, ethnicity, academic background, academic aptitude, and computer skills constant. Furthermore, the study reported higher satisfaction rates amongst the cyber-learners compared to traditional students. Similarly, Harmon and Lambroni [35] found that the likelihood of answering a question correctly on an economics exam is significantly higher if the material was instructed and covered online versus in-class instruction. The authors continued to suggest that online instruction results in better academic performance compared to traditional face-to-face instruction in a classroom. Comparing student performance in computer science courses taught both on campus and online, Dutton, *et al.* [29] found that the online learners performed better than the on-campus students. One possible explanation offered by Dutton is that the online learners tend to be older, employed, have children, and are more serious, experienced, and skilled in a variety of aspects compared to the younger on-campus college students. In a study comparing student achievement in management courses taught online and on-campus, Wilson and Allen [36] concluded that "the assertion that online students perform poorly relative to face-to-face students was not supported."

Controlling for gender, prior math knowledge, and high school grades, Brown and Liedholdm compared student performance in macroeconomics by measuring test scores, finding that the on-campus students performed better than the online students [37]. Similarly, Coates, *et al.* [38], compared student achievement in the macroeconomics section, and also concluded that after controlling for age, working hours, and prior college experience, the face-to-face learners outperformed their online counterparts. In a recent report titled "Online Course-Taking and Students Outcomes in California Community Colleges," the results indicated that the on-campus learners who received face-to-face instruction outperformed those who opted to take online classes across the state community college system. The authors concluded that "whichever way we look at it, we are finding consistently that students are performing better in the face-to-face sections versus the online sections" [39].

The wide variation in the findings regarding the effectiveness of online instruction when compared to face-to-face course delivery is resultant of a number of methodological problems. First, selection bias characterizes a large number of the samples used in the above cited studies; namely, the researchers have not randomly assigned students into online or face-to-face courses [29], [33], [34]. On the contrary, the students self-selected the medium of instruction that best satisfied their need or desire. This jeopardizes the representativeness of the samples, especially when the researchers are only comparing one or two courses, totalling a small number of students. Second, few studies compared more than

two courses, making it difficult to generalize based on the small samples [35]–[37]. Making bold inferences, such as online learning being as good, better, or worse than face-to-face instruction, requires a larger sample. Most studies including online and face-to-face courses do not exceed one hundred students combined [29], [32], [36], [38]. While researchers tried to control for instructor differences, material variation, and course variation by making these as uniform as possible, small student samples when taking the same course, at the same college, with similar academic and demographic backgrounds jeopardizes the key element of any sample: its representativeness. Third, most comparisons of online and face-to-face instruction were conducted by researchers who taught the courses themselves [34], [36]–[38]. This results in inducing a certain degree of bias generated by the participation of the researcher. Researcher bias in social and behavioural research is unavoidable [40], [41]. The instructors' choices, interactivity levels, motivation, charisma, instructional rigor, and other contextual factors are likely to influence the comparison results and make the online instructions appear more or less effective compared to the face-to-face instructions [35], [38]. Most comparisons of the course delivery methods do not provide sufficient information on possible researcher biases that could influence the inferences based on their findings.

III. BENEFITS OF E-LEARNING

In a report reviewing one thousand empirical studies, the U.S. Department of Education noted that a greater number of well-documented benefits resulted from e-learning. First, e-learning allowed students to access the content of the courses at any time and from any place [42], [43]. E-learning also focuses on offering options to students unable to attend face-to-face settings or those who wish not to partake in the same learning experiences as traditional students [14]. In addition, e-learning allows for the distribution of learning materials in a more cost-effective manner [45], [46]. Lastly, e-learning permits the instructors to reach out to more students while maintaining equivalent standards of learning quality [42], [44], [46].

In studying the benefits brought about by the adoption of e-learning in developing countries, Olson, *et al.* [47], concluded that students, teachers, and both the economies and societies in such areas would be greatly improved with the implementation of e-learning [47]–[49]. The report concluded that the use of laptops in student learning experiences fosters team work qualities, independent learning habits, the development of greater critical thinking, and problem-solving skills in addition more time spent on homework, thus enhancing the overall learning experience [12], [17], [43]. E-learning also positively impacts the performance of teachers who can utilize a variety of means to motivate students, identify weaknesses to better target student challenges, and become overall better teachers through learning new technologies that are likely to improve the quality of their teaching [50], [51]. E-learning by its very nature introduces both

students and teachers to new technologies, equipping both groups with the necessary skills and knowledge essential for economic success in today's world. E-learning generally enhances the overall skillset of students as well as teachers, improving their chances of obtaining and maintaining employment.

Studies of e-learning in Saudi Arabia have highlighted the importance of such approaches in expanding educational opportunities available for women and hard to reach populations [18], [20]. First, the Saudi educational system is based on Islamic tradition, where men and women are not allowed to interact within the same classroom [19], [21]. This requires universities to offer equivalent versions of courses for each gender. E-learning makes this process less expensive, and quality control is better guaranteed by allowing the same instructors to teach online or through an internally utilized system accessible to both sexes [25]. Second, many areas of the Kingdom suffer from limited access to universities. This population can be more readily reached through the use of online education conveyed wirelessly [26].

Additionally, e-learning could potentially be used as an alternative model to traditional education in crisis and disaster areas. Olson, *et al.* [47], concluded that e-learning was a potential solution to the educational problems in Libya following the February 14th revolution that resulted in the death of Libyan leader Muammar Al Gaddafi. In the authors' words

“E-learning appears to be a promising alternative. It can provide learning opportunities anytime anywhere. It enables students and instructors to use a wide range of Internet based tools to communicate, collaborate and share resources, and open up accessible educational opportunities. ICT and e-learning could be used (as reconstructive and attractive measures) to support the affected learners and instructors in Libya.”

The ongoing conflict between Saudi Arabia, its allies, and the Houthi rebel group and supporters in Yemen has resulted in the closure of schools in many areas of southern Saudi Arabia along the border. E-learning has emerged as a viable alternative for many institutions such as Najran University, which closed its classrooms in 2015 for safety concerns. With the institutionalization of e-learning as an alternative to traditional face-to-face learning, Najran University has overcome the political crisis by delivering its educational mission and standards online.

This study aims to investigate whether there is a tangible difference in the academic performance between students attending face-to-face courses and those enrolled online. Furthermore, the study explores whether e-learning can serve as an effective system overcoming some of the challenges brought on by man-made or human crises such as interstate conflict. The case study analysed here is that of a large public university located in southern Saudi Arabia where all of its



FIGURE 1. Adapted online teaching theoretical framework.

computer science courses were moved online due to safety concerns.

IV. HYPOTHESES, DATA AND METHODS

This study hypothesizes that students' academic performance does not differ based on the medium of course delivery in higher education institutions in the Kingdom of Saudi Arabia. Further, the research hypothesizes that e-learning can fulfil educational outcomes in a comparable fashion to face-to-face educational settings. Available data from the Computer Science department at Najran University in southern Saudi Arabia is utilized. Najran University suspended on-campus learning due to ongoing conflicts between the Arab Coalition led by Saudi Arabia and Yemeni rebel groups spearheaded by the Houthi Group. The Department of Computer Science at Najran University has collected detailed information on students' enrolment, withdrawal, passing, and course completion rates, allowing the comparison between face-to-face and online learning. Najran University was established only recently with a royal decree from King Abdullah Bin Abdulaziz in 2005, quickly becoming the largest public university in the Kingdom with an 18-million square meters campus. The university has two campuses, one for males and the other for females, with fifteens and ten colleges respectively. The university intended to accommodate 45,000 students and currently has a total enrolment of 14,000 students in its undergraduate and graduate programs.

This research tests the effectiveness of an e-learning program developed by the Department of Computer Science at Najran University based on Andrade's [52] online teaching theoretical framework. The model depicted in Figure 1 integrates three of the most widely theoretical frameworks in the distance education literature: Self-Regulated Learning Model, Transactional Model and Collaborative Learning Practices Model. This model starts with designing courses that compel learners to exercise goal-setting, development and application of strategies, review of the implementation of those strategies and fulfilment of set educational objectives. In addition, the course content, materials, syllabi and supporting services are designed with organized channels of communication, interaction and dialogue with students. Instructors are trained in fostering collaboration and

harnessing help-seeking practices among learners polishing off the educational experience with a socially conducive environment for collaboration and sustained learning. The resulting e-learning program aimed at aggrandizing learners' autonomy, self-direction and self-regulation to support individual learning attitudes, behaviors and improvement.

This framework suggests how distance education and e-learning initiatives can blend transactional education models, self-regulation learning models and collaborative practices into a unified online delivery system. While the model dimensions overlap and share few similar characteristics such as structured, organized and facilitating mediums of learning and instruction, each component is distinctly fostering an independent pillar of distance education. In the end, this increases learners' self-regulation, structure, autonomy and educational performance.

The data used in this study comes from two different years, one taught traditionally in face-to-face instructional settings and the other taught online using Learning Management Systems (specifically Blackboard). All students were tested on-site for final examinations regardless of the medium of instruction. This analysis excluded directed study, independent projects, and graduation capstones because such courses are tailored to one individual with a specific scope. Table 1 presents the course names taught in all four semesters (two in the face-to-face year and two in the online education year). Note that courses taught in one semester but not in the other were excluded in order to reduce non-comparable cases Measures.

Thirty-six courses with a total enrolment of over 1,000 students over the four semesters are included in this analysis. Each semester includes the same courses with varying enrolment numbers. Face-to-face semesters exhibited higher enrolments compared to online semesters. Please note that this was the first time in the history of the Saudi higher educational system, where a department transferred all its courses from traditional settings to an e-learning environment. Subsequently, there has been a steady decrease in computer science courses at the university and online enrolment is lower than that of face-to-face courses. Note that students and courses included in this analysis come from both the male and female campuses at Najran University. Most students come from the city of Najran, an urban area, and are enrolled in the undergraduate curriculum of the department or other colleges around the university. Most students are within the age range of 18 to 22 years old. Courses were taught by the same instructors in both semesters, decreasing the influence of instructional rotation and instructors' interactivity levels.

The main dependent variable in the analysis is students' academic performance. This outcome is measured using various indicators to cross-validate results obtained from the analysis. First, the number of passing students in each course serves as a simple indicator of students' performance. The higher the number of passing students, the higher students' performance in the course is considered. Second, the percentage of passing students (passing rates) is another indicator

TABLE 1. Course name and enrolments in the two semesters.

Course Name
Visual Programming
Database Foundations
Information Systems Design and Analysis
Modern Approaches for Application Programming
Database Systems Architecture
Database Systems Administration
Database Systems Engineering
Database Systems Project Management
Computer Networks and Data Communication
Database Systems Strategies
Information Networks Administration
Electronic Business
Multi-medium Technologies
Internet Application Development
Decision Support Systems
Information Systems Security Administration
Computer Programming 1
Object Oriented Programming
Design and Analysis of Algorithms
Computer Organization and Collection Language
Unix Environment
Operating Systems
Theories of Computing
Computer Graphics
Human-Computer Interaction
Computer Architecture for CS Majors
User Interface Programming
Programming Engineering
Design and Construction of Translators
Artificial Intelligence
Foundations of Database Management Systems
Modern Topics in Computer Science
Computer Security
Social, Ethical and Professional Issues
Parallel and Distributed Systems
Internet Technologies
Total: 36

of student performance. The higher the percentage among those who took the entire course and final examinations (and were not terminated, suspended, or withdrawn), the higher is a course's level of student performance. Finally, withdrawal rates are taken as another indicator of student performance. The higher withdrawal rates are in a course, the lower the rates of students' performance are recorded. Note that the correlations between the three variables are sufficiently high as evident in Table 2 which prompts the conclusion that all such indicators measure a latent construct, student academic

TABLE 2. Means of passing rates by course delivery method.

Variable	Passing Rates	Passing Students	Withdrawn Students
Passing Rates	1.0	0.83	-0.78
Passing Students	0.83	1.0	-0.82
Withdrawn Students	-0.78	-0.82	1.0

performance. Taking all these measures together, analysts can better evaluate student performance in face-to-face as well as online learning environments.

The primary independent variable in this analysis is the course delivery medium, a categorical indicator coded 0 if the course was taught online and 1 if the course was taught face-to-face. This leads to the conclusion that the unit of analysis in this research is the individual course. Information about courses, however, informs stakeholders on student academic performance. Since this research is aimed at establishing the direction and strength of relationships among course delivery method and student academic performance, the appropriate research strategy proves to be quantities correlational design.

To evaluate the proposed hypotheses, a simple comparative analysis between the means of course passing rates, passing students and withdrawn students in the face-to-face learning environment and online learning semester is carried out. Since the courses taught are the same in four consecutive semesters, a paired sample exists. Therefore, the analysis utilizes the paired samples t-test to evaluate the statistical and practical significance of the mean differences in student performance between face-to-face and online learning settings, if existent. The paired t-test is a repeated measure design that is more powerful compared to other designs such as between group designs.

V. RESULTS

Table 3 displays all 36 courses with passing rates in each year. Note the value for passing rate is an average for the course across two semesters, considered for each corresponding year. The right-hand column presents the difference between face-to-face values and online learning values. Note that passing rates refers to the percentage of those students who passed the course from the total number of students who were admitted into the final examination phase. For instance, if ten students in a computer science programming course were admitted into the final examination period and all passed the passing rate would equal 100. The table indicates that 26 online courses have a passing rate of 100% compared to about 17 courses in the face-to-face learning environment.

Face-to-face courses had a higher rate of passing students, with 24 courses featuring a higher number of passing students in a face-to-face environment compared to about 8 courses having online courses surpass face-to-face participation in terms of the number of passing students. Twenty-seven courses had the same number of withdrawn students regardless of the medium of instruction, and all such cases had zero

TABLE 3. Course name and their passing rates.

Course Name	Face-to-Face Enrolment	Online Enrolment	Difference
Visual Programming	(88)	(100)	(-12)
Database Foundations	(88)	(100)	(-12)
Information Systems Design and Analysis	(50)	(67)	(-17)
Modern Approaches for Application Programming	(100)	(100)	(0)
Database Systems Architecture	(89)	(100)	(-11)
Database Systems Administration	(100)	(100)	(0)
Database Systems Engineering	(71)	(50)	(21)
Database Systems Project Management	(100)	(100)	(0)
Computer Networks and Data Communication	(80)	(100)	(-20)
Database Systems Strategies	(100)	(86)	(14)
Information Networks Administration	(100)	(75)	(25)
Electronic Business	(95)	(91)	(4)
Multi-medium Technologies	(89)	(71)	(18)
Internet Application Development	(100)	(100)	(0)
Decision Support Systems	(92)	(100)	(-8)
Information Systems Security Administration	(82)	(100)	(-18)
Computer Programming I	(79)	(50)	(29)
Object Oriented Programming	(31)	(100)	(-69)
Design and Analysis of Algorithms	(89)	(100)	(-11)
Computer Organization and Collection Language	(100)	(100)	(0)
Unix Environment	(67)	(100)	(-33)
Operating Systems	(89)	(100)	(-11)
Theories of Computing	(100)	(100)	(0)
Computer Graphics	(100)	(90)	(10)
Human-Computer Interaction	(100)	(100)	(0)
Computer Architecture for CS Majors	(100)	(100)	(0)
User Interface Programming	(83)	(100)	(-17)
Programming Engineering	(71)	(0)	(71)
Design and Construction of Translators	(100)	(100)	(0)
Artificial Intelligence	(86)	(50)	(36)
Foundations of Database Management Systems	(91)	(100)	(-9)
Modern Topics in Computer Science	(100)	(100)	(0)
Computer Security	(100)	(100)	(0)
Social, Ethical and Professional Issues	(100)	(100)	(0)
Parallel and Distributed Systems	(100)	(100)	(0)
Internet Technologies	(100)	(100)	(0)

students withdrawn from classes. In about 14 courses, the difference between passing rates in face-to-face and online courses exceeded 10 points. In fact, in 4 courses the passing rate exceeded 30 points of difference. Thirteen courses

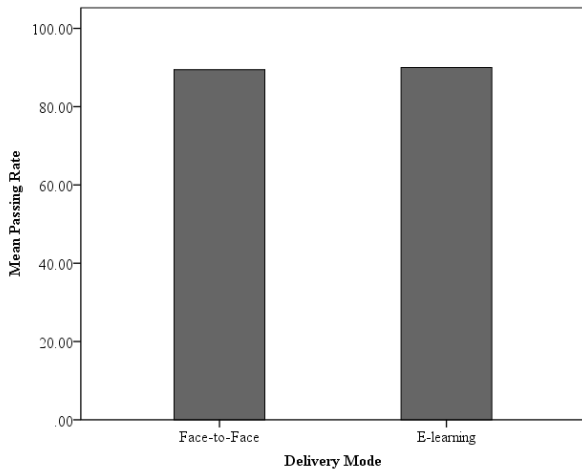


FIGURE 2. Passing rates.

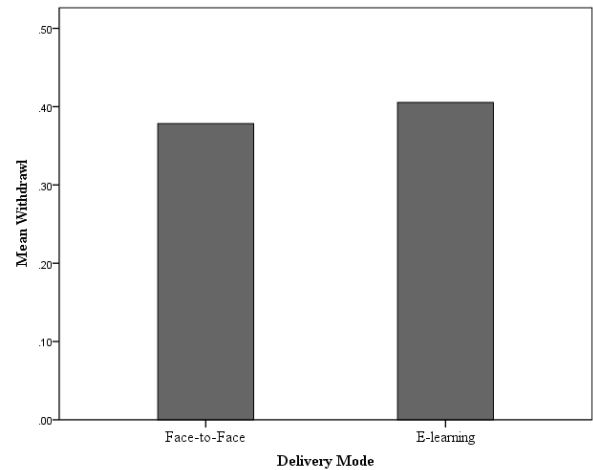


FIGURE 4. Withdrawn students.

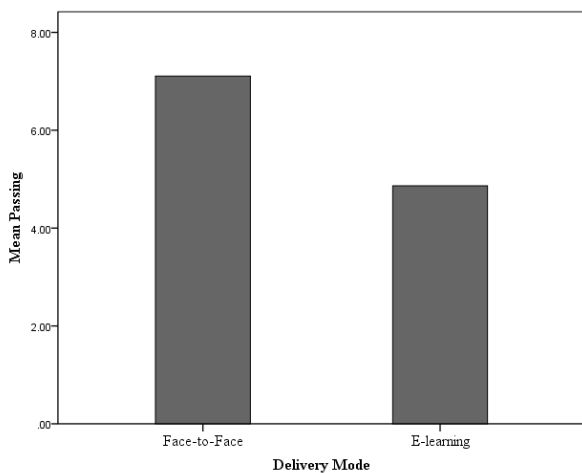


FIGURE 3. Quantity passing.

had higher passing rates for online courses compared to 9 face-to-face courses. Fourteen courses had the same passing rate in both semesters. The results show marked differences in passing rates and the number of passing students dependent on the medium of instruction. Simultaneously, the findings show no real differences in terms of the number of withdrawn students among the courses based on whether they were delivered online or face-to-face. Those differences, however, are seen on the individual course level and the inspection at the aggregate level follows below.

Figure 2 displays a bar chart with the course delivery mode, face-to-face versus online, on the x-axis while the mean of passing rates for courses in the 4 semesters is on the y-axis. Notice that in both years, the mean of passing rates was about 90%. The bars show a little difference, indicating that online courses had a higher rate compared to face-to-face courses. Nevertheless, such a difference seems to be negligible, 0.5 or half a point. Figure 3 displays a bar chart depicting the mean of passing students on the y-axis and course delivery mode on the x-axis. The figure shows

TABLE 4. Means comparison between face-to-face and online courses.

Delivery Mode		Withdrawal	Passing	Passing Rate
Face-to-Face Learning	Mean	.3784	7.1081	89.4595
	N	37	37	37
	Std. Dev.	.82836	3.73262	15.37782
E-learning	Mean	.4054	4.8649	90.0000
	N	37	37	37
	Std. Dev.	1.01268	3.53681	21.55871
Total	Mean	0.3919	5.9865	89.7297
	N	74	74	74
	Std. Dev.	.91887	3.78350	18.59835

a difference of 2.3 students; 7.1 for face-to-face courses and 4.8 for e-learning courses. This difference is non-negligible and may be partly due to the larger number of students who attended face-to-face courses compared to online courses. Figure 4 displays the mean of withdrawn students in face-to-face courses and online courses. The findings indicate that the difference is miniscule, 0.3. Such figures demonstrate that face-to-face and online courses have similar passing rates and numbers of withdrawn students.

Conversely, they differ with respect to the number of passing students due to the larger student body size that enrolled in face-to-face courses compared to online classes.

Table 4 displays the means, standard deviations, and sample sizes for the number of withdrawn students, number of passing students, and passing rates for face-to-face and online courses. As previously indicated, results show little difference between course means with respect to passing rates and the number of withdrawn students. Further, the means seem to differ significantly, which will be assessed more below, with respect to the number of passing students. Despite the

TABLE 5. Paired t tests results.

		Paired Samples Test							
		Paired Differences			95% Confidence Interval of the Difference		t	df	Sig.
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	Passing1 - Passing2	2.24324	4.6452	0.76367	0.6944	3.79204	2.937	36	0.006
Pair 2	Passing Rate1 - Passingrate2	-0.54054	21.613	3.55324	-7.7468	6.66577	-0.152	36	0.880
Pair 3	Withdraw11 - Withdraw12	-0.02703	0.8655	0.14230	-3.1563	0.26158	-0.190	36	0.850

mean differences regarding the number of passing students, the distribution of the variable is similar with respect to the standard deviation (3.7 for face-to-face learning versus 3.5 for online learning), suggesting similar distributional characteristics. This indicates that the likely explanation for the mean difference is simply the larger size of student enrolment in the face-to-face semester.

Table 5 presents the results of three paired sample t-tests on passing rates, the number of passing students, and the number of withdrawn students. Please note that each course included in the analysis received two measurements, one is the average for the two face-to-face semesters and one for the two online learning semesters. This allows detecting the statistical and practical differences in means among the three variables. Results indicate that mean differences with respect to passing rates and the number of students withdrawn from courses are not statistically significant, with p-values of 0.880 and 0.850 respectively. The confidence intervals for both variables at the 95% level contains zero in them, indicating that the mean differences are not statistically significant. The slight difference in means yields no practical significance in the two variables. On the other hand, the p-value corresponding to the number of passing students is 0.006 with a t-value of 2.93 indicating statistical significance. This result is consistent with the large practical means' difference between face-to-face and online courses with respect to the number of passing students. This result may be due to the larger number of students who registered in the face-to-face year compared to the online learning year.

This research tested an integrated e-learning framework based on self-regulation learning models, transactional distance learning and collaborative practices. The model presented in Figure 1 was supported by Najran University's experience. Student academic performance in Computer Science was found to be satisfactory and equal to that obtained through face-to-face instruction. The department's data indicated that the Computer Science faculty designed well-structured courses that helped students in fostering goal setting, applying helpful learning strategies and monitoring their progress. Further, evidence indicates that the level of interactivity between faculty and students, as well as students with each other was high, fostering a collaborative learning environment. Finally, Najran's online experience provided evidence that well designed online education fosters adequate learner autonomy capable of improving student academic performance.

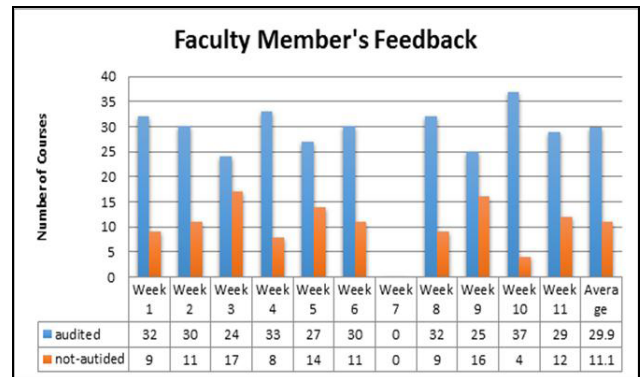


FIGURE 5. Overall faculty participation.

Figures 5-9 present findings based on an internal departmental assessment of faculty performance throughout the e-learning year. First, the department reported that there was a high participation rate from the faculty teaching online. Figure 5 shows that on average, 82% of the teaching faculty have provided the department with information about their courses throughout the 11-week long semester. By the same token, Figure 6 displays the percentage of content uploaded by faculty members throughout the semester. The graph indicated that on average, 87% of faculty members uploaded their materials online for students to use throughout the semester. Figure 7 indicates that faculty members heavily used the virtual classes, resulting in a semester average of 83%. Figure 5 suggests that on average, 18% of classes were missed due to technical problems per week, and Figure 8 shows that the faculty members experienced a moderate number of technical issues while teaching online with an average of almost 30% a week. Figure 9 shows that almost half of the lectures were recorded through the Learning Management System used by the department.

Those graphs indicate that faculty members were actively engaged in utilizing the available resources for teaching their assigned courses online. The high percentages of faculty participation, low percentage of missed classes, and the moderate number of technical issues coupled with high rates of course accomplishment as outlined above, shows that the e-learning experience within the department has proved to be quite successful.

Results indicated that face-to-face and online learning do not significantly differ. The paired t-test findings alluded that the mean differences in passing rates

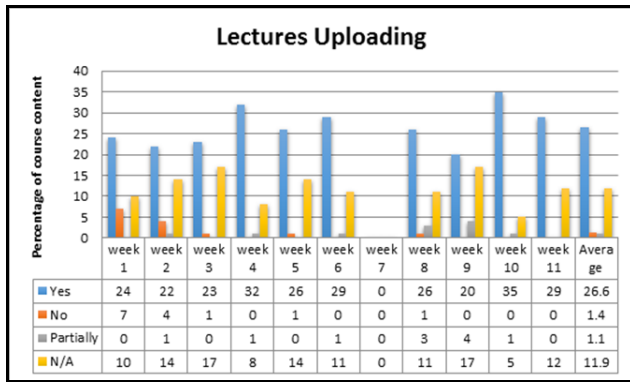


FIGURE 6. Overall faculty participation in uploading lectures.

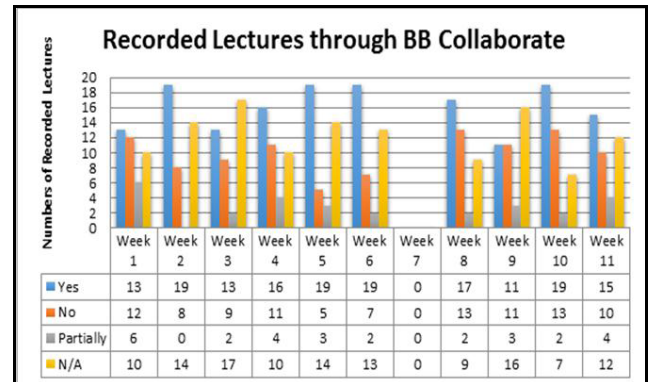


FIGURE 9. Overall percentage of recorded lectures through BB collaborates.

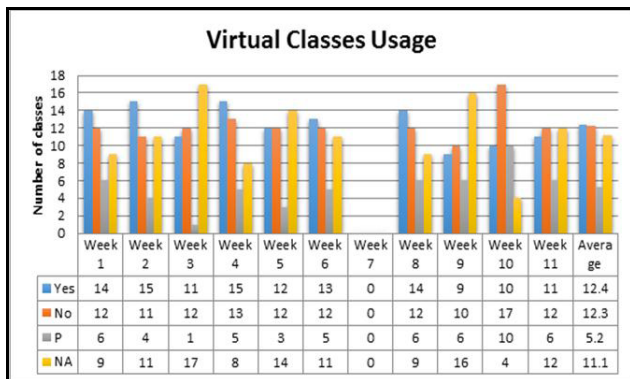


FIGURE 7. Overall faculty usage of virtual class in the blackboard systems.

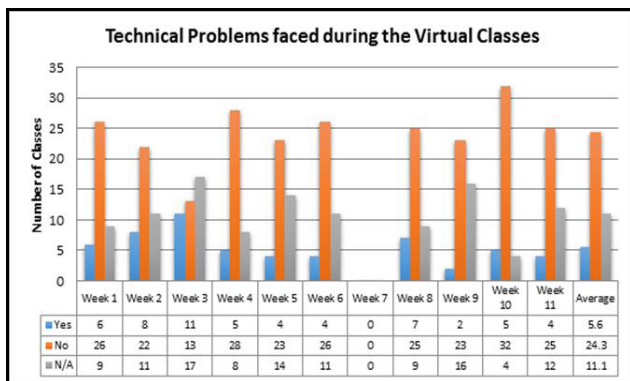


FIGURE 8. Overall number of technical problems faced.

and the number of passing students were not statistically or practically significant. With respect to the number of withdrawn students, the difference in means was statistically significant; however, the larger size of enrolment in the face-to-face instruction semester may have generated such a result. The internal departmental investigation has established that faculty actively participated, delivered, and evaluated learning outcomes during the e-learning semester. This indicates that online education is as effective as face-to-face instruction, yielding similar results.

VI. DISCUSSION AND CONCLUSION

This study supports the no significance hypothesis, suggesting that a student's performance does not differ with respect to the educational delivery mode (face-to-face versus online) [2], [4], [6], [8], [11]. While this research is novel given its exploration of a new context (Saudi Arabia) and breadth (inclusion of all courses offered by a large computer science department), the findings of the study confirm the earlier results by concluding that the course delivery technique has little impact when it comes to justifying the course passing rates. It is difficult to generalize these findings across all Saudi universities, departments, or Middle Eastern higher learning institutions, though such findings should persuade opponents of e-learning implementation by demonstrating that it carries the same, if not better, results than traditional face-to-face learning.

One of the main findings is that enrolment rates in the online semester were significantly lower than the face-to-face semester. This difference may be due to students' increased fears of taking online courses. Notice that Najran University's experiment with online teaching is the largest and first of its kind in the Kingdom. Students perceive online courses as lacking in support, interactivity, connectivity, and as more difficult academically. For such reasons, Saudi students are likely to avoid registering in online courses. University administrators should increase student confidence levels in online education through an awareness campaign showing the mechanics, logistics, usefulness, accessibility, and interactivity of online courses. University faculty should receive formal training in delivering course contents through Learning Management Systems and following best practices for teaching via online platforms. While universities in Saudi Arabia are expanding their online education programs, they still need to do more work to harness students trust in e-learning.

This study's findings challenge popular perceptions among educators as well as policy-makers in Saudi Arabia and the Middle East about the effectiveness of e-learning. These perceptions include: lower quality of education offered by e-learning compared to face-to-face settings, the lack of

need given comprehensive on-campus programs, insufficient knowledge about the nature, implementation, or potential of e-learning, and the substantial bureaucratic burdens associated with creating new e-learning programs.

Further, this study demonstrated that e-learning in Saudi Arabia is capable of delivering the same, if not better, educational quality as that provided by traditional delivery settings. It has also shown that the implementation and maintenance of e-learning courses and programs does not involve the contracting of immense resources. Given the outcomes, this research contributes to the efforts of adopting and expanding e-learning initiatives across the region.

In addition, this study has shown the power of Information Communications Technologies (ICTs) in overcoming challenges such as war or natural disasters by delivering the educational mission and vision of higher learning institutions remotely. E-learning has proven to be a successful course delivery method at Najran University. The Computer Science Department was able to engage its faculty, staff, and resources to teach all of its courses online while the university closed its doors for traditional learning due to the worsening humanitarian conditions resulting from the political crisis between Saudi Arabia and Yemen. While the student evaluations of their online experience are not well documented, the data obtained from the department indicated high levels of success characterizing the e-learning program at Najran University.

This research opens paths for future research on the impact of e-learning on student performance in the Middle East, an unexplored area of inquiry. It also encourages future study on the applicability and potential of e-learning in areas unraveled by political instability and conflict. E-Learning is developing exponentially across the Kingdom of Saudi Arabia and the Middle East generally. Therefore, more concern should be devoted to its effectiveness, implementation, and impact on students' academic and non-academic outcomes.

Natural disasters in the form of hurricanes, wildfire, floods, famines, or civil and interstate conflicts regularly prevent millions of children, college students, and adult learners from accessing brick and mortar schools, colleges, or universities. E-learning can mitigate the magnitude and severity of these impacts on education delivery. Refugees in host countries may fully access wired computer labs connected to university and school servers abroad. Thus, access to education for vulnerable groups such as refugees or those affected by natural disasters improves significantly with the prospects of e-learning. The use of e-learning as an alternative medium of education for all levels should be seriously considered in areas suffering from emergencies such as a number of Middle Eastern nations including Syria, Iraq, Libya, Yemen, and Lebanon.

At best, E-learning costs less than constructing and maintaining educational facilities. It also requires a lower number of academic and administrative staff. E-learning eliminates heavy dues and the hefty requirements of running large educational facilities, proving to be a solution for delivering basic

educational curriculum to suffering populations. It can also be administered from a long distance, connecting the best brains available and desiring to assist in lessening the hardships faced by affected student groups. The best example can be offered by large Massive Open Online Courses platforms such as Coursera. Despite the shortcomings of any online educational medium, it can at least be accessed by hard to reach populations who can have access to the study material online and practice what they learn using virtual machines from their homes, cafes, designated learning labs, or anywhere connected to the internet. For all such reasons, e-learning is an effective tool in delivering educational goals in crises ridden areas such as the southern borders of Saudi Arabia.

This research contributes to the efforts of making higher education more accessible, efficient and sustainable in Saudi Arabia as well as in other areas are affected by disasters, natural or otherwise. Najran's university experience provides compelling evidence that the university curriculum, instruction and evaluation can reach more students faster through its e-learning program than its brick and mortar apparatus. Equity in education is defined by two components: access and quality. Delivering educational content by Saudi universities online can reach the same desired population targeted through face-to-face approaches. Student performance rates in the computer science department, one of the toughest areas of education across the university, did not fall in the e-learning program. On the contrary, in many courses, students' academic achievement improved significantly. Faculty members reported high levels of self-reported satisfaction with the quality of courses delivered online at Najran university. Informal assessments by the College, department and allied staff exhibited high levels of approval with the statement, "online courses provide equal if not superior quality education to traditional methods of instruction." One of the more increasingly used indicators to measure quality of courses is students' satisfaction.

Detailed discussions with students who enrolled in both sessions, the face-to-face and online phases, reported higher satisfaction with the online delivery method. This is due to the ease of access, processing and retrieval of course materials posted on Blackboard. All in all, online education seems to score higher on equity, access and quality than face-to-face instruction. E-learning serves as a sustainable form of education. It is cheaper to provide online courses than on-campus courses. E-learning utilizes less material resources, less human capital and is more agile compared to face-to-face education. E-learning not only saves universities undue costs to broaden the educational, service or research endeavors of students and faculty, but also delivers education and resources in a timely, easily tractable and monitored fashion. Therefore, this paper supplies higher education stakeholders in Saudi Arabia with telling results that Najran university's experience with e-learning presents Saudi students with more equitable, accessible, quality and sustainable education compared to face-to-face approaches.

This research does not only present an on-going extensive debate on whether e-learning provides satisfactory educational gains, but also tests the effectiveness of an e-learning program in a previously neglected context: the Saudi higher education system. It also outlines the potential benefits offered by e-learning in war-ridden zones. This research offers a real success story where e-learning delivered efficient, equitable, accessible and high-quality education to students who could not attend classes due to an ongoing war. This is a novel research agenda attempting to address an internationally forgotten crisis, inadequate access to high quality higher education in hard to reach geographic areas, war-zones, areas suffering from epidemics, natural disasters, civil wars or other types of emergencies.

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REFERENCES

- [1] M. S. Albalawi, "Critical factors related to the implementation of Web-based instruction by higher-education faculty at three universities in the Kingdom of Saudi Arabia," Ph.D. dissertation, Dept. Instruct. Perform. Technol., Univ. West Florida, Pensacola, FL, USA, 2007.
- [2] S. S. Jaggars and T. Bailey, *Effectiveness of Fully Online Courses for College Students: Response to a Department of Education Meta-Analysis*. New York, NY, USA: CCRC Publications, 2010.
- [3] S. B. Eom, H. J. Wen, and A. Ashill, "The determinants of students' perceived learning outcomes and satisfaction in university online education: An empirical investigation," *Decision Sci., J. Innov. Edu.*, vol. 4, no. 2, pp. 215–235, Jul. 2006.
- [4] K. Swan, "Learning effectiveness: What the research tells us," in *Elements of Quality Online Education, Practice and Direction*, J. Bourne and J. C. Moore, Eds. Needham, MA, USA: Sloan Center for Online Education, 2003, pp. 13–45.
- [5] L. Harasim, "Shift happens: Online education as a new paradigm in learning," *Internet Higher Edu.*, vol. 3, nos. 1–2, pp. 41–61, 2000.
- [6] I. Jung and R. Ilju, "Effectiveness and cost-effectiveness of online education: A review of the literature," *Edu. Technol.*, vol. 40, no. 4, pp. 57–60, Jul./Aug. 2000.
- [7] T. Volery and D. Lord, "Critical success factors in online education," *Int. J. Edu. Manage.*, vol. 14, no. 5, pp. 216–223, 2000.
- [8] G. Kearsley, *The Effectiveness and Impact of Online Learning in Graduate Education*. New York, NY, USA: CCRC Publications, 1995.
- [9] I. E. Allen and J. Seaman, *Sizing the Opportunity: The Quality and Extent of Online Education in the United States, 2002 and 2003*. Newburyport, MA, USA: Sloan Consortium, 2003.
- [10] I. E. Allen and J. Seaman, *Learning on Demand: Online Education in the United States, 2009*. Newburyport, MA, USA: Sloan Consortium, 2010.
- [11] D. Lim, M. Morris, and V. Kupritz, "Online vs. blended learning: Differences in instructional outcomes and learner satisfaction," *J. Asynchronous Learn. Netw.*, vol. 11, no. 2, pp. 27–42, 2007.
- [12] B. Bell and J. E. Federman, "E-learning in postsecondary education," *Future Children*, vol. 23, no. 1, pp. 165–185, 2013.
- [13] A. Lizzio, K. Wilson, and R. Simons, "University students' Perceptions of the learning environment and academic outcomes: Implications for theory and practice," *Stud. Higher Edu.*, vol. 27, no. 1, pp. 27–52, 2010.
- [14] S. Lee, "Examining the relationship among student perception of support, course satisfaction, and learning outcomes in online learning," *Internet Higher Edu.*, vol. 14, no. 3, pp. 158–163, Jul. 2011.
- [15] J. Herrington, R. Oliver, and T. C. Reeves, "Patterns of engagement in authentic online learning environments," in *Proc. ASCILITE Conf.*, Auckland, New Zealand, Dec. 2002, 2002, pp. 279–286.
- [16] L. Y. Muilenburg and Z. L. Berge "Student barriers to online learning: A factor analytic study," *Distance Edu.*, vol. 26, no. 1, pp. 29–48, 2007.
- [17] T. Anderson, Ed., *The Theory and Practice of Online Learning*. Edmonton, AB, Canada: Athabasca Univ. Press, 2008.
- [18] A. M. Alaugab, "Benefits, barriers, and attitudes of Saudi female faculty and students toward online learning in higher education," Ph.D. dissertation, Dept. Teach. Leadership, School Edu., Univ. Kansas, Lawrence, KS, USA, 2007.
- [19] A. K. Hamdan, "The reciprocal and correlative relationship between learning culture and online education: A case from Saudi Arabia," *Int. Rev. Res. Open Distrib. Learn.*, vol. 15, no. 1, pp. 309–336, 2014.
- [20] F. N. Al-Fahad, "Students' attitudes and perceptions towards the effectiveness of mobile learning in king Saud University, Saudi Arabia," *Turkish Online J. Edu. Technol.*, vol. 8, no. 2, pp. 1–9, 2009.
- [21] M. Alamri, "Higher education in Saudi Arabia," *J. Higher Edu. Theory Pract.*, vol. 11, no. 4, pp. 88–91, 2011.
- [22] S. Lloyd, M. Byrne, and T. McCoy, "Faculty-perceived barriers of online education," *J. Online Learn. Teach.*, vol. 8, no. 1, p. 1, 2012.
- [23] R. Alebaikan and S. Troudi, "Blended learning in Saudi universities: Challenges and perspectives," *ALT-J. Res. Learn. Technol.*, vol. 18, no. 1, pp. 49–59, 2010.
- [24] A. B. Nassuora, "Students acceptance of mobile learning for higher education in Saudi Arabia," *Amer. Acad. Scholarly Res. J.*, vol. 4, no. 2, pp. 135–140, 2012.
- [25] A. M. Al-Shehri, "E-learning in Saudi Arabia: 'To E or not to E, that is the question,'" *J. Family Community Med.*, vol. 17, no. 3, pp. 147–150, 2010.
- [26] H. Yamani, "E-learning in Saudi Arabia: Challenges and opportunities," *J. Inf. Technol. Appl. Edu.*, vol. 3, no. 4, pp. 169–172, 2014.
- [27] D. R. Garrison and H. Kanuka, "Blended learning: Uncovering its transformative potential in higher education," *Internet Higher Edu.*, vol. 7, no. 2, pp. 95–105, 2004.
- [28] S. Sussman and L. Dutter, "Comparing student learning outcomes in face-to-face and online course delivery," *Online J. Distance Learn. Admin.*, vol. 13, no. 4, p. n4, 2010.
- [29] J. Dutton, M. Dutton, and J. Perry, "How do online students differ from lecture students?" *JALN*, vol. 6, no. 1, pp. 1–20, 2002.
- [30] T. Russell, *The No Significant Difference Phenomenon*. Chicago, IL, USA: IDECC, 2001.
- [31] S. Hijazi, P. Bernard, M. Plaisent, and L. Maguiraga, "Interactive technology impact on quality distance education," *Electron. J. e-Learn.*, vol. 1, no. 1, pp. 35–44, 2003.
- [32] Y. Zhao, J. Lei, B. Yan, C. Lai, and H. S. Tan, "What makes the difference? A practical analysis of research on the effectiveness of distance education," *Teach. College Rec.*, vol. 107, no. 8, pp. 1–49, 2005.
- [33] C. A. Dell, C. Low, and J. F. Wilker, "Comparing student achievement in online and face-to-face classes," *J. Online Learn. Teach.*, vol. 6, no. 1, p. 30, Mar. 2010.
- [34] P. Navarro and J. Shoemaker, "Performance and perceptions of distance learners in cyberspace," *Amer. J. Distance Edu.*, vol. 14, no. 2, pp. 15–35, 2000.
- [35] O. Harmon and J. Lambrinos, "Student performance in traditional vs. online format: Evidence from an MBA level introductory economics class," Dept. Econ., Univ. Connecticut, Storrs, CT, USA, Econ. Working Paper 200703, 2007.
- [36] D. Wilson and D. Allen, "Success rates of online versus traditional college students," *Res. Higher Edu. J.*, vol. 14, pp. 1–9, Dec. 2011.
- [37] B. W. Brown and C. E. Liedholm, "Can Web courses replace the classroom in principles of microeconomics?" *Amer. Econ. Rev.*, vol. 92, no. 2, pp. 444–448, 2002.
- [38] D. Coates, "'No significant distance' between face-to-face and online instruction: Evidence from principles of economics," *Econ. Edu. Rev.*, vol. 23, no. 5, pp. 533–546, Oct. 2004.
- [39] C. M. D. Hart, E. Friedmann, and M. Hill, "Online course-taking and student outcomes in California community colleges," *Edu. Finance Policy*, vol. 13, no. 1, pp. 42–71, 2018.
- [40] R. J. Chenail, "Interviewing the investigator: Strategies for addressing instrumentation and researcher bias concerns in qualitative research," *Qualitative Rep.*, vol. 16, no. 1, pp. 255–262, 2011.
- [41] E. A. Dieckman, "A procedural check for researcher bias in an ethnographic report," *Res. Edu.*, vol. 50, no. 1, pp. 1–4, Nov. 1993.
- [42] L. Harasim, "Online education: The future," in *Computer Networking and Scholarly Communication in the Twenty-First-Century University*, T. Harrison and T. Stephen, Eds. Albany, NY, USA: SUNY Press, 1996, pp. 203–214.

- [43] B. Means, Y. Toyama, R. Murphy, M. Bakia, and K. Jones, "Evaluation of evidence-based practices in online learning: A meta-analysis and review of online learning studies," U.S. Dept. Edu., Office Planning, Eval., Policy Develop., Washington, DC, USA, Tech. Rep., 2010.
- [44] B. Means, Y. Toyama, R. Murphy, and M. Bakia, "The effectiveness of online and blended learning: A meta-analysis of the empirical literature," *Teach. College Rec.*, vol. 115, no. 3, pp. 1–47, 2013.
- [45] S. J. Bartley and J. H. Golek, "Evaluating the cost effectiveness of online and face-to-face instruction," *J. Edu. Technol. Soc.*, vol. 7, no. 4, pp. 167–175, 2004.
- [46] M. Simonson, *Teaching and Learning at a Distance: Foundations of Distance Education*. London, U.K.: Pearson, 2011.
- [47] J. Olson *et al.*, "An analysis of e-learning impacts & best practices in developing countries: With reference to secondary school education in Tanzania," ICT4D Program, Michigan State Univ., East Lansing, MI, USA, Tech. Rep., 2011. [Online]. Available: https://www.researchgate.net/publication/272682458_An_Analysis_of_e-Learning_Impacts_Best_Practices_in_Developing_Countries_With_Reference_to_Secondary_School_Education_in_Tanzania
- [48] J. Capper, "E-learning growth and promise for the developing world," *TechKnowLogia*, vol. 3, no. 2, pp. 7–10, 2001.
- [49] A. S. Sife, E. T. Lwoga, and C. Sanga, "New technologies for teaching and learning: Challenges for higher learning institutions in developing countries," *Int. J. Edu. Develop. ICT*, vol. 3, no. 2, pp. 57–67, 2007.
- [50] J. Sandholtz, *Teaching With Technology: Creating Student-Centered Classrooms*. New York, NY, USA: Teachers College Press, 1997.
- [51] P. A. Ertmer, "Teacher pedagogical beliefs: The final frontier in our quest for technology integration?" *Edu. Technol. Res. Develop.*, vol. 53, no. 4, pp. 25–39, Dec. 2005.
- [52] M. S. Andrade, "Effective eLearning and eTeaching—A theoretical model," in *E-Learning - Instructional Design, Organizational Strategy and Management*. Rijeka, Croatia: InTech, 2015.

KHAIRAN D. RAJAB (M'06) received the bachelor's degree from the University of South Carolina, USA, the master's degree from the University of South Florida, USA, and the Ph.D. degree in computer science and engineering from the University of Southern Florida, under the supervision of Prof. L. A. Piegl. He is currently an Assistant Professor, the Vice Dean of e-learning and distance education, and the Head of the Network and Communication Engineering Department, College of Computer Science and Information Systems (CSIS), Najran University, Najran, Saudi Arabia. He has published over 16 research papers in high impact factor journals and reputable conferences. His research interests are geometric modeling, NURBS, data mining, network security, and cyber learning. He is a member of the College Council, CSIS. He is a reviewer and on editorial board of several research conferences and journals.

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