Digitalization of learning in Saudi Arabia during the COVID-19 outbreak: A survey

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ABSTRACT

Following the outbreak of the novel coronavirus (COVID-19) in China in late December 2019, more than 217 countries became almost immediately infected in the resulting pandemic. Consequently, many of them decided to close their educational institutions as a way of preventing the spread of this virus. For many of them, though, the closure made them unable to deliver learning materials to students owing to their inability to provide the right technology for the purpose. To assist with the digitalizing of learning during this time, this study reviews the most common technologies used in the delivery of learning materials, with the experience of most infected countries being considered. Major challenges in online learning are discussed in this study as well. Further, Saudi Arabia was considered as a case study for the effectiveness of distance learning during the 2020 spring semester, where 300 undergraduate students were surveyed on their opinions of distance learning. The responses to the survey indicated that distance learning was effective in providing the required knowledge to the students during the outbreak of COVID-19. The findings showed that although the lack of interaction and poor internet connections were factors affecting comfortable and successful learning of physics and mathematics, 63% of students were satisfied with learning management systems, 75% of students found it easy to understand course materials, and 67% of students found it easy to understand assignments and could deal with them comfortably. The study findings can encourage educational institutions to digitalize their learning materials in the future.

1. Introduction

Currently, the Coronavirus outbreak (COVID-19) is affecting many countries all over the world [1]. Various steps have been taken to deal with this outbreak, of which the educational standpoint is one.

In some countries, the Ministry of Education has acted to deliver education via the internet [2–6]. The need for e-learning following the outbreak of the pandemic prompted educational institutions to use virtual classes instead of the traditional classes in teaching students [7–11]. From the viewpoint of epidemiology, this may be regarded as the best immediate reaction, but for educators, it has posed a challenge as they must appropriately reformat learning materials to fit the needs of students. Meanwhile, although issues associated with e-learning delivery have been extensively examined by various researchers [11–15], none have addressed those associated with information technologies used in the promotion of educational activities following outbreaks such as COVID-19. Thus, this study will present an overview of education and e-learning during COVID-19 outbreak in some countries, followed by Saudi Arabia as a case study for the effectiveness of distance learning during the COVID-19 outbreak. This study would thus be of value to those educational institutions that are trying to digitalize their learning materials during the outbreaks of COVID-19.

The following sections demonstrate the education and the e-learning during COVID-19 outbreak in some countries, followed by Saudi Arabia as a case study for the effectiveness of distance learning during the COVID-19 outbreak.

1.1. China

The outbreak of the coronavirus became a major disruption to colleges and universities across the country, with most institutions canceling in-person classes and moving to online-only instruction [2, 15–17]. To provide flexible online learning to over 270 million students, the Ministry of Education launched an initiative entitled 'Disrupted classes, undisrupted learning' [2].

Accordingly, in their efforts to conserve equality in education while allowing students to sustain their studies during the outbreak, the universities in China introduced a digital instructional platform equipped with ultra-modern digital tools for the delivery of various courses [2]. [18] The model, even though considered a contingent delivery method, covered distance teaching and learning for all students, international and worldwide. The pandemic has led to the impetus for shifting from campus-based learning into complete online degrees. For this reason [19–21], indicated the need for online education to go viral.

Because COVID-19 is extremely contagious, face-to-face interaction between instructors and students became very risky [22–24]. Therefore, the government of China ordered the closure of campuses which resulted in the endorsement of Massive Online Learning Courses (MOOCs). As reported in Refs. [18,25] MOOCs are facilitated by live-streaming apps and synchronized videoconferencing systems including Zoom, Skype, Alibaba's DingTalk, and Google Hangouts. Furthermore, to provide consistent educational services, a national portal known as the "National Cloud-Platform for Educational Resources and Public Service" was launched [4]. Thus, within only a few weeks, COVID-19 had pushed the route of higher education into digital learning.

Through live broadcasts, learning cloud platforms and virtual reality tuition, roughly 120 million students in inland China could gain access to and share learning materials. Further, following the government initiative of introducing national internet cloud educational services [25,26], indicated that the trend had become consolidated. Also, following the diagnosis of initial cases, over twenty platforms of online curriculum, 24,000 courses for higher education institutions, and library digital resources have been almost immediately offered at no charge [22]. In Hong Kong and other territories of China, most students have begun using interactive apps in their home-bound learning [26].

In China, the burgeoning of 5G technology has presented an impetus for the pervasiveness of novel modalities of digital education [27], and yet, accordingly to Zinan (2020), it generated pedagogical efficacy of digital modalities of education that is affected by the downsides of the online education system infrastructure. The effect of some aspects of the digital divide on the engagement of students and instructors within the context of distance education has also been noticed. As has be stated, the COVID-19 public health crisis has brought attention to the notions of "digital divide", or "digital exclusion," whereby, for areas that are more impoverished or more rural with only basic digital technology infrastructures [28], the medium for online learning would be more challenging to construct. At the same time, access to digital information sources does not assure the occurrence of learning, and this makes the credibility of online pedagogy debatable [29].

Chinese authorities have decisively launched advanced digital learning programs to mitigate the dangers of face-to-face instruction [30,31]. However, the programs were unsystematic and short-term. This situation was caused by the fact that the shift from offline to online education was helping to diminish the epidemic. Furthermore, the significant success of digital education requires a high level of systematic collaboration among higher education institutions to allow the formation of a new cloud-based online learning and broadcasting platform, and upgraded education infrastructure [26,32].

1.2. India

India took second place after the USA regarding confirmed cases of COVID-19 and the number of coronavirus patients kept increasing [33, 34]. As reported in Ref. [3], such an expanding number of cases in India paralyzed various aspects of Indians' lives. As options for conventional education of various levels, countless schools, universities, and companies in India have opted to use e-learning and smart working. So, the digital vision of the Indian government is emerging as a vital tool to solve the COVID-19 crisis. Because technology-based education is very transparent in all aspects. many initiatives were undertaken by the government of India, as well as private players and state governments to face this challenge.

As a preventive measure for COVID-19, the Government of India declared a lock-down of all educational institutions countrywide on 16 March 2020. On March 18 the Central Board of Secondary Education (CBSE) postponed all schools' examinations throughout India. It released guidelines for centers of examination about conducting examinations by distance, maintaining and reducing the number of students in the classrooms [3].

Some arrangements were made by the Ministry of Human Resource Development (MHRD), including educational channels and online portals direct to radios and home TVs. To continue learning by students, popular social media like Zoom, WhatsApp, Google Meet, Youtube live, Telegram, etc were used by the students for online learning during the lockdown. An initiative of CT, MHRD (e-Broucher-https://mhrd.gov.in/ict-initiatives) is a novel platform that combines all online education's digital resources [3].

Aside from preventing students from potential COVID-19 infection through traditional face-to-face learning, online learning also helps students with contradictory time courses [35]. Also, as there are no costs associated with transportation and student accommodation, online learning is a cost-effective option for students. With the current situation, online learning and home-schooling should be considered as feasible education options at various levels. Accordingly, the universities in India implemented digital technologies in an effort to minimize the detrimental effect of placing the entire nation under quarantine [35]. Hence, in these universities, all courses, exams, and researches were digitalized and delivered through online courses, while thesis defenses were done via videoconferences. On the other hand, lab-based courses could be put on hold until the end of quarantine when life was back to normal again [36].

1.3. USA

Higher education was disturbed by the COVID-19 outbreak. The 2020 spring campus shutdowns were directed to a rapid transformation into "distance learning," exposing the adoption of digital capabilities and high-quality education technology across thousands of universities and colleges. The 2020 fall semester, complete with terminated openings of campus and widely diverging blended and online options, has only amplified the pressure on America's universities and colleges [37].

Relevantly, before the COVID-19 outbreak some universities had resolved the problem of staff shortages by the application of multimedia platforms [38]. Shifting to virtual classes was highly necessary during the pandemic situation, but the shift needed creative learning activities and deep contemplation on how to carry out the assessments. At Johns Hopkins University (JHU), Zoom and Panopto were the two web-based video-conferencing tools that could be used by faculty members in communicating and delivering lectures to students [39]. Cruickshank (2020) indicated that the shift to online learning may be difficult because face-to-face and virtual classes are distinct from one another. In the USA, many colleges and universities have shifted to online learning to replace conventional face-to-face classroom instruction [40,41], however, it is not a simple process because many faculty members find educational technologies a foreign concept. Also, as reported in Pfleger

(2020), many students had no access to fast and dependable Internet services. After schools reopened in September 2020, the coronavirus was infecting American children and teens increasingly, caused by school reopening.

As of Sept. 24, the AAP counted nearly 625,000 youth cases, with a 14% increase over the previous two weeks. Deaths totaled 109, which is under 1% of all COVID-19 deaths in the USA [42]. The AAP research is based on reports from public health departments in 49 states, Washington, D.C., New York City, Guam, and Puerto Rico [42].

1.4. Spain

In Spain, INTEF, Procomún, and Educlan platforms were launched during the COVID-19 outbreak. INTEF encompasses educational tools, resources, and applications accessible to families, teachers, and the students themselves that facilitates distance learning [43]; Procomún offers approximately 100,000 educational resources and learning objects [44]; and Educlan is an online channel [45].

Meanwhile, the University of Deusto in Spain introduced Moodle, a free and open-source learning management system, as a resource for supporting teaching [46]. Further, Google Meet was also implemented by the university to allow students and their instructors to carry out video conferencing [47,48]. Additionally, virtual communication was encouraged through emails, Google Calendar, Google Drive, and Google Hangouts. Online universities that offer online learning were available in this country, and among the prominent ones are the Spanish Open University [49] and the National Distance Education University (UNED).

Within the context of most universities in Spain, the transition into distance and online learning from traditional face-to-face learning has raised the question of whether the transition is adequately good for the students [49]. For some, distance/online learning signifies the application of just the diverse technological tools, as exemplified by recorded lectures, PowerPoint slides, simulations, educational platforms, PDFs, virtual reality (VR), and so forth [7]. opined that distance/online learning that is dependable on technical tools does not take into account the quality that affects the interaction between students and instructors. The adopted pedagogical model has hence become the most integral factor.

An educational platform was accordingly introduced by the Spanish Ministry of Universities and the Conference of Rectors to allow the instructors and their students to virtually be present in the classes [5]. The platform was primarily for UNED and UOC, to guide and provide training resources for instructors so that they could transform their face-to-face classes into virtual ones [50].

1.5. Germany

To dampen the COVID-19 spread, Germany forced restrictions on both schools and universities. In dealing with the crisis, the Technical University of Munich (TUM) implemented online learning [51], and the instructors were advised to teach online [52]. In converting the traditional classes into virtual classes, the instructors were furnished with a booklet entitled "Flexible Solutions for Digital Teaching" [53]. Using the booklet, they could determine the correct tools in delivering a lecture, seminar, or meeting online, record different online activities and produce educational videos [53].

1.6. South Korea

South Korea took different measures when compared to many other countries because the country used the functional and consistent standard operation procedure in dealing with risk factors in public health crises [54,55]. In this country, the COVID-19 outbreak led to the closure of higher educational institutions, retrieval of students who study abroad, and prohibition of public gatherings to curb the outbreak [55–58]. Being highly equipped technologically, South Korea used mobile maps, undiscerning awareness-raising and smartphone apps equipped with GPS maps to methodically observe the infection spread [58].

As an attempt to curb the spread of infection and consequently decrease the rate of mortality, South Korea is a prominent example of smartphone apps usage. Comparatively, within the context of education, South Korea had not shown significant development. Universities in South Korea had not provided significantly meaningful online learning experiences to their students, both national and international, to compensate for the prohibition of traditional face-to-face learning as a result of the outbreak. Ironically, at the global level, education in South Korea is very competitive. The author in Ref. [59] reported that the outbreak has caused a failure of higher educational institutions in South Korea to mitigate the negative feedback of frustrated students.

A significant portion of technological resources in South Korea has been dedicated to saving lives, especially through the generation and use of smartphone apps. In this regard, there are two primary aims through two apps: (a) the first app was designed to execute mass testing and tracking of suspected cases; and (b) the second app educated the population about the deterrent mechanisms. Accordingly, those entering South Korea, especially those from the highly affected regions, had to use the first app. The app redirects users to a teleworking executive to regularly report any suspicious symptoms.

As for the second app, it sends a notification to public health officials each time a person departs the isolation zone. However, this app is not compulsory. At the same time in South Korea, a daily comprehensive transparent information report is produced by the Centers for Disease Control and Prevention to educate the public, with the specific aim of improving the understanding of both experts and citizens of the evolution and systems of the virus, while providing pertinent data to ease the concerns of the population at large. The information is conveyed through the national mobile phone alert system [60].

With a penetration rate of higher than 90%, the digital divide in South Korea is negligible. Still, university students in this country would consider recorded video lectures a poor alternative to face-to-face instruction. Accordingly, Lau et al. (2020) have linked this phenomenon with the design of university online platforms that mimic MOOCs and allow very minimal interactive learning experiences. Nonetheless, based on multimedia application [4], indicated the use of the educational broadcasting system in South Korea as a national portal that furnishes learners with progressive educational services.

In South Korea, narrowing the digital divide has not been linked to sustainable strategic planning for the management of the crisis in education because, as opposed to risk management in healthcare sectors, it appears highly embryonic. In fact, in South Korea, the focus has been on the use of smart apps and high-speed connectivity as supports for the fast epidemic containment via consistent disclosure of comprehensive and updated information to the public, social distancing, instantaneous widespread testing, and digital monitoring of quarantined individuals [61,62].

As can be deduced, South Korea focused on the aggressive use of smart technologies as proactive measures to halt the exponential growth cycle of the infection. In doing so, the author in Ref. [63] stated that the quality of online substitutes to the traditional face-to-face learning during campus lockdowns was compromised. As described in Ref. [64], the outbreak of COVID-19 was handled through the integration and readjustment of various forms of artificial intelligence to allow the sharing, diffusing, processing, and interchanging the high-quality digital data between the public and government organizations on time, as this allowed crucial decisions to be made to eliminate the epidemic.

However, the measures taken by South Korea have led to the question of whether the capital investment in information technology should be allocated to the healthcare industry or to education during the outbreak of disease. It raises the question of whether the educational sectors need well-established benchmarks to achieve a useable standard operation procedure that foresees, and congruently employs, a

comprehensive system of digital solutions when educational institutions are ordered to close for an emergency.

1.7. Italy

Italy took second place after China regarding confirmed cases of COVID-19 in the beginning of the COVID-19 outbreak when the number of coronavirus patients steadily increased [34]. As reported in Ref. [65], the expanding number of cases in Italy has paralyzed various aspects of Italian lives. As options to conventional education of various levels, countless schools, universities, and companies in Italy have chosen to use e-learning and smart working. However [65], indicated that smart working is not suitable in the context of factories because it cannot handle the issues associated with processes of production and workflows. Hence, the digital transformation is not a panacea to all problems caused by the outbreak of COVID-19.

In Italy, the education minister, Lucia Azzolina announced the closure of all academic establishments in the country on March 4th, 2020 and the closure was to take effect from March 5th, 2020 to March 15th, 2020, involving all schools and universities. Later, the closure was extended to April 3rd, 2020 [6,65,66]. Accordingly, two national portals were launched in Italy to deal with the closure situation, namely "La Scuola continua" and "Nuovo Coronavirus". The former was dedicated to school students while the latter demonstrated the procedures of handling COVID-19 in emergency cases [4].

In delivering lectures to students, Associate Professor Loveless (2020) of the University of Bologna Italy used Microsoft Teams, a platform that offers integrated communication and collaboration, and a teamwork hub in Microsoft Office 365 Suite. This platform allows file storage, group chat, video meetings, as well as online meetings hosting. Furthermore, Microsoft Teams are operational on desktop and mobile devices aside from being compatible with nearly all available operating systems. Also, online learning allows students to learn from their homes irrespective of their distance from their schools or universities, and therefore, the use of online learning is regarded as a sound alternative in resolving the academic establishments' closure issue. In this regard, the University of Bologna decided to transform all its traditional convertible courses to online courses, except for some inconvertible ones such as lab courses [36]. Also, as the library of the university was also closed, this crisis would ease the academic establishments to speed up the process of adopting digital technologies for teaching [36].

Aside from preventing students from potential COVID-19 infection through traditional face-to-face learning, online learning also eases students with contradictory time courses. Also, as there are no costs associated with transportation and student accommodation, online learning is a cost-effective option for students. With the current situation, online learning and home-schooling should be considered as feasible education options at various levels. Accordingly, the universities in Italy implemented digital technologies in an effort to minimize the detrimental effects of placing the entire nation under quarantine. Hence, in these universities, all courses, exams, and researches were digitalized and delivered through online courses, while thesis defenses were done via videoconferences. On the other hand, lab-based courses could be put on hold until the end of quarantine and life was back to normal once again [36].

Finally, some conceptually similar studies are worth mentioning such as [67–69]. In their studies, they successfully applied the fractional natural decomposition method (FNDM) for investigating COVID-19 in a numerical illustration by the spreading of some dependent variables of the COVID-19 system. They claimed that because the Caputo derivative and integral are recognized as suitable explanations of real-world problems, they introduced the effectiveness of the considered derivative. They explained how the transfer model occurs from reservoir to human. They also presented wave behaviors of infection and other features of the COVID-19 outbreak. Thus, the results obtained using FNDM for COVID-19 are spreading shortly. They aimed to help researchers better understand the physical behavior of the novel coronavirus. They claimed that the fractional-order method allows for more flexible investigations and deeper methods of observing COVID-19 behaviors. The main novelty of their work is that the simulation changes according to different fractional-order values. Their method is effective, accurate, and can be applied to the analysis of many diverse classes of coupled nonlinear problems that exist in science and technology. In short, they have made a comprehensive investigation on the mathematical system of COVID-19 using FNDM for more effective and accurate results. Although the field of study and application are completely different from ours, implementation and perspective are common. We intended to implement the same abovementioned method of investigation or perception in our study which may present the need for digitalizing learning in the time of COVID-19 pandemic.

2. A survey on distance learning in Saudi Arabia during outbreak COVID-19

Saudi Arabian general education changed in the spring semester of 2020 [9,70–74], following the rise of coronavirus COVID-19 infection cases to 344,875, while world-wide at October 25, 2020, there were over 43,344,504 million infected. A total of 217 countries have suspended their processes of education, including Saudi Arabia.

The impact of Virtual classes on students' learning outcomes is discussed in this study. For this purpose, this study sought the opinions of undergraduate students to understand the efficiency of online education in universities in Saudi Arabia during the COVID-19 outbreak. Accordingly, the effect, pros and cons, and recommendations of online learning are viewed in this study. Data were obtained from the samples using online survey questionnaires.

Because of the lockdown, the questionnaires were distributed to undergraduate International and Saudi university students in Saudi Arabia. The domains of the questionnaires are as follows, where each domain has five items:

- Internet/ LMS is effective as a learning tool.
- Virtual Classrooms are effective compared to Physical Classrooms.
- The study material is easy to be understood by distance learning.
- In Distant Learning, the assignments given are easy to be understood.

Fig. 1 shows the study sample distribution.

There were 300 students of Saudi Universities who took part in the study, 255 of them were from Saudi while the remaining 45 were international students from countries including Egypt, Sudan, China, Philippines, India, and Pakistan. Immediately after the COVID-19 outbreak, some of the international students returned to their homeland and resumed their studies via virtual classes. Students find online classes effective in resolving certain study-related problems, but sometimes it has some drawbacks, as online classes lack interaction. This is particularly relevant for subjects such as physics and mathematics. The survey participants were randomly selected out of the total study population. Table 1 shows the distribution of the sample members based on the study variables.
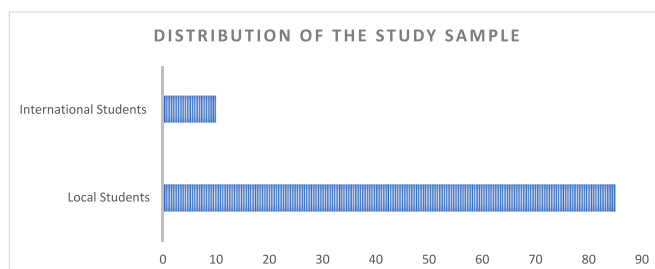

Fig. 1. The study sample distribution.

Table 1
The distribution of the sample members based on the study variables.

	Categories	Frequency	Percentage
Respondents Student	Student	300	
Gender	Male	115	38.3%
	Female	185	61.7%
Nationality	Saudi	255	85%
	Non- Saudi	45	15%
Year of study	1st	122	40.7%
	2nd	83	27.7%
	3rd	64	21.3%
	4th	31	10.3%

2.1. Questionnaire validity and consistency

The contents and validity of the questionnaire has been verified by ten reviewers from university professors who specialize in educational administration. They studied the questionnaire and expressed their opinion on the number of its paragraphs or any notes they deem appropriate to change or deletion. Their observations and suggestions were studied, and any paragraph that obtained an agreement at 80% was adopted as a measure of their acceptance.

Paragraph correlation coefficients for each section were extracted with the total score for the domain to which they belong. This was achieved by conducting a pilot study of 30% of students. Because Pearson correlation coefficients represent a sign of validity for each paragraph in the form of a correlation coefficient between each paragraph and the overall degree of the section to which it belongs. This was implemented using the statistical package for social science (SPSS) software.

The paragraphs' correlation coefficients for measuring the degree of students' satisfaction with the whole questionnaire ranged between (0.586–0.803), and each domain (0.679–0.838). See Tables 2 and 3.

It should be noted that all correlation coefficients are of acceptable degrees and statistically significant. Therefore, none of the paragraphs was deleted. It is clear from Tables 2 and 3 that all correlation coefficients for the questionnaire domains and the questionnaire are high. Thus, they are suitable for the study. This indicates the strength of the internal cohesion (consistency) of the paragraphs for each domain in the questionnaire.

Table 2
Correlation coefficients between paragraphs and the overall degree and the domain to which they belong.

Item No.	Correlation Coefficients vs Domain	Correlation Coefficients vs Questionnaire
1	.836[a]	.762[a]
2	.780[a]	.655[a]
3	.772[a]	.741[a]
4	.765[a]	.646[a]
5	.811[a]	.778[a]
6	.710[a]	.621[a]
7	.816[a]	.777[a]
8	.710[a]	.660[a]
9	.838[a]	.803[a]
10	.758[a]	.677[a]
11	.813[a]	.789[a]
12	.708[a]	.637[a]
13	.752[a]	.739[a]
14	.744[a]	.672[a]
15	.766[a]	.754[a]
16	.718[a]	.662[a]
17	.816[a]	.722[a]
18	.696[a]	.586[a]
19	.820[a]	.731[a]
20	.679[a]	.587[a]

*Correlation is significant at the 0.05 level.
[a] Correlation is significant at the 0.01 level.

The questionnaire is validated for consistency using reliability statistics and Cronbach's alpha. All consistency coefficients of the questionnaire's domains are of high values and suitable for the study. See Table 4.

2.1.1. Internet/ LMS is effective as learning tools

Most students expressed their satisfaction with the virtual guidance provided by teachers. Also, the materials provided via LMS were sufficient in addressing most of the questions by students. One of the issues that affect distance learning negatively is the interruption through poor internet connection. The percentage of student's responses is highlighted in Fig. 2.

As shown in Fig. 2, most students (63%) expressed satisfaction towards LMS and other available tools for e-learning, while 18% expressed dissatisfaction, and 19% were neutral toward it.

2.1.2. Virtual Classrooms are effective compared to physical classrooms

Fully online classes sometimes were interrupted due to poor internet connection. A poor internet connection caused students to repeatedly sign into the online class until the class ends. On the other hand, the online class provides students with direct answers most of the time. but the students cannot clarify their questions sometimes. Also, the provided answers to the question may not be clearly understood – the situation is the opposite of physical classrooms. The percentage of student's responses is displayed in Fig. 3.

2.1.3. The study material is easy to be understood by distance learning

Most of the students can understand most of the study material, but some of the course material, especially practical courses, appears difficult to understand online. The percentage of student's responses is displayed in Fig. 4.

Most participants (75%) viewed the course material as able to be understood with the aid of teachers and online tools. Thus, external support is needed for only 20% of the students who expressed that the course material was difficult to be understood.

2.1.4. In Distant Learning, the assignments given are easy to be understood

Daily, during quarantine time, students were to complete and submit a new assignment, and the assignments generally contained some difficult questions, which might affect the course grading if not submitted as stipulated. In this regard, assistance is needed so that students could understand the purpose and how the solution is provided. The percentage of students' responses is displayed in Fig. 5.

As shown in Fig. 5, most (67%) participants saw that the assignments were easy to understand and could be completed easily, especially with the assistance of the teachers.

3. Results and discussion

The COVID-19 outbreaks have forced many countries to shut down their educational institutions, schools, and universities, leading to a paradigm shift in the process of education, whereby face-to-face classrooms were transformed into virtual ones. However, Teras et al. in Ref. [75] have concluded that many institutions failed to determine the correct technology to deliver the learning materials to the students. This study provided a review of the implemented leading technologies in delivering the learning materials, focusing on the country's most initially affected, to assist the affected institutions in digitalizing their learning during this pandemic. Technologies of education implemented in China, Italy, India, the USA, Spain, Germany, and South Korea were accordingly reviewed.

Equally, there are potential challenges in shifting to online learning. First, for many faculty members and students, the technologies may appear foreign. Another challenge is the lack of internet access particularly in some areas. Also, traditional classrooms and online learning have significantly different quality, and such differences may impede

Table 3

Correlation coefficients between domains and the overall score.

Domain	The effectiveness LMS as a learning tools	The effectiveness of Virtual Classrooms compared to Physical Classrooms	Ease of understanding the educational material	Ease of understanding the given assignments
The effectiveness LMS as a learning tools	1			
The effectiveness of Virtual Classrooms compared to Physical Classrooms.	0.772**	1		
Ease of understanding the educational material	0.713**	0.802**	1	
Ease of understanding the given assignments	.740**	.745**	0.750**	1

Table 4

The internal consistency coefficient of Cronbach's alpha and stability for domains and the total score of the questionnaire.

Domain	Stability	Internal Consistency
The effectiveness LMS as a learning tools	.891	.949[a]
The effectiveness of Virtual Classrooms compared to Physical Classrooms	.933	.974[a]
Ease of understanding the educational material	.891	.948[a]
Ease of understanding the given assignments	.951	

*Correlation is significant at the 0.05 level.
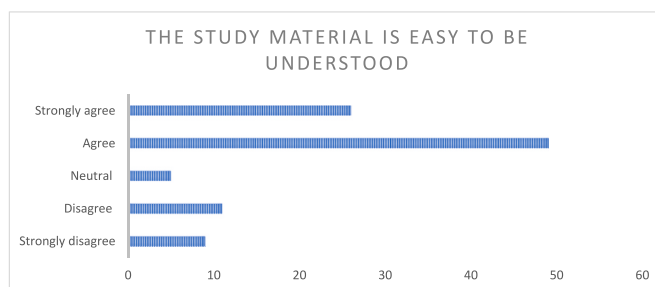
[a] Correlation is significant at the 0.01 level.

Fig. 4. Percentage of Student's responses.
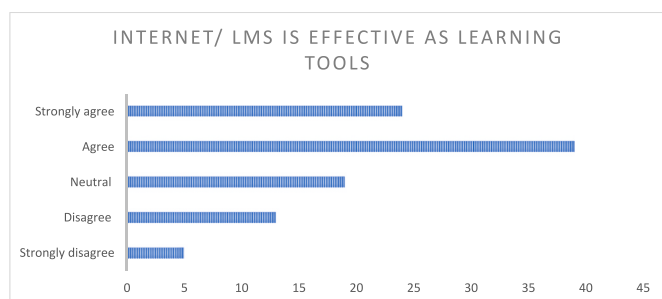

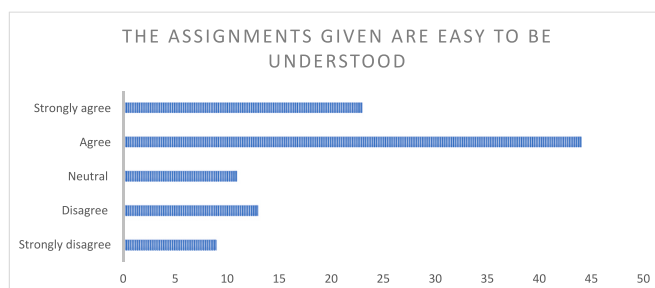**Fig. 2.** Percentage of Student's responses.
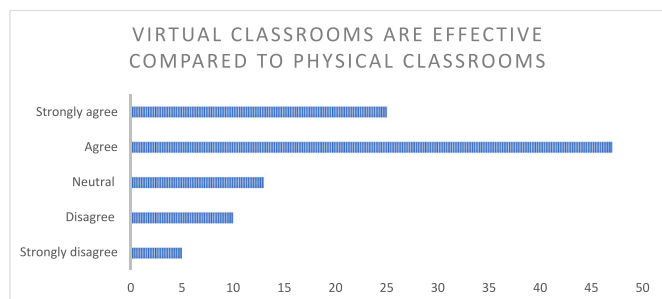

Fig. 5. Percentage of Student's responses.

Fig. 3. Percentage of Student's responses.

the transition to online classes.

Saudi Arabia was considered as the main focus of the survey for the effectiveness of distance learning during the 2020 spring semester, where 300 undergraduate students were surveyed on their opinions of distance learning. The responses to the survey indicated that distance learning was effective in providing the required knowledge to the students during the outbreak of COVID-19, the study findings can encourage educational institutions to digitalize their learning materials in the future.

Maheshwari [76] concluded that online learning in developing countries is still at its infancy stage. Where, many students faced difficulties to learn due to different learning styles, lack of self-confidence,

poor internet connectivity, underdeveloped instructional design. All these factors are impacting student learning intentions in the future. Hence, based on the results of his study, online learning might be impacted due to poor connectivity and slow connection. Thus, in our point of view, the lack of interaction and poor internet connection are the major factors affecting comfortable and successful learning, therefore, hindering an effective learning environment with fast and more accessible internet.

The study sample was 300 students, including Saudis and international students who were involved in online classes (physics and mathematics). It was found that 63% of students expressed satisfaction towards LMS and other available e-learning tools, while 18% expressed dissatisfaction, and 19% were neutral toward it. With the aid of teachers and online tools, 75% of students found it easy to understand course materials. The rest found it difficult to be understood. Similarly, this also applies to 67% of students who found that the assignments were easy to understand and could be completed easily, especially with the assistance of the teachers.

However, long-term incorporation of online learning into university curricula and attention to quality is required. The future steps should focus on:

1. The continuous development of open educational platforms that permit access to the high quality of education resources.

2. Conducting qualitative and quantitative research for evaluating the existing models of e-learning focusing on its long-term use and sustainability.
3. Developing the instructors' skills for e-learning, and professional staff skills to support instructors' and online systems.
4. Encouraging cooperation between civil society, international organizations, universities, private sector, and other participants, for promoting high-quality e-learning.

As in some related studies as in Ref. [49], again this brought our survey to the question of "whether the transition is adequately good for the students" Within the context of most universities in Saudi Arabia, the transition into distance and online learning from traditional face-to-face learning had an effect on the adequacy for a student's satisfaction.

Hence, the following subsections further present and discuss the study results as well as questionnaire correction procedures.

3.1. Results of the study

Based on the responses of individuals of the study sample and their statistical readings, the findings are presented and discussed as follows.

3.1.1. Results related to the degree of satisfaction
"Whether the transition is adequately good for the students" expressing students' satisfaction to what degree they are satisfied.

To answer this question, the means and standard deviations are extracted for the students' satisfaction. The following table illustrates the statistics for the four domains.

Table 5 illustrates that the overall score for means of all domains is (3.73), while standard deviations (0.66) with a high degree. Means of all domains range between (3.95–3.64) mostly with high degrees. The first domain "The effectiveness LMS as a learning tools" obtained the highest degree of all (mean = 3.95; standard deviation = 0.88) while the fourth domain "Ease of understanding the given assignments" was in the last rank with low degree (mean = 3.64; standard deviation = 0.73).

3.1.2. Results related to the statistically significant differences
Are there statistically significant differences at significant level ( ) between means of study sample estimates of the degree of satisfaction traced to gender, nationality, and year of study variables?

To answer this question, the means and standard deviations are extracted for the students' satisfaction. To clarify statistical differences between the means, a *t*-test was conducted for each variable. The following tables illustrate the statistics for the three variables.

Table 6 shows that there are statistically significant differences at ($\alpha \leq 0.05$) traced back to the gender in all domains and the overall degree, where the differences are in favor of males in all domains.

Table 7 shows that there are statistically significant differences at ($\alpha \leq 0.05$) traced back to the nationality in all domains and the overall degree, where the differences are in favor of Saudis in all domains.

Table 8 shows that there are statistically significant differences at

Table 5
Means and standard deviations of the degree of students' satisfaction.

Rank	No.	Domain	Mean	Standard Deviation	Degree
1	1	The effectiveness LMS as a learning tools	3.95	0.88	High
2	3	The effectiveness of Virtual Classrooms compared to Physical Classrooms	3.84	0.87	High
3	2	Ease of understanding the educational material	3.80	0.88	High
4	4	Ease of understanding the given assignments	3.64	0.73	Medium
Overall score of the questionnaire			3.73	0.66	High

($\alpha \leq 0.05$) traced back to the year of study in all domains and the overall degree, where the differences are in favor of 1st in the first two domains, while they are in favor of 2nd year students in the last two domains, as well as in the overall degree.

3.2. Discussion

3.2.1. Questionnaire correction procedures
For accrediting certain standards dealing with the study results, each article has been given a weight according to the 5-point Likert scale, where each article has one degree among five, including: very high (5 points), high (4 points), medium (3 pints), low (2 points), very low (1 point). For more interaction with the results the 5-point scale is transformed into a 3-point scale based on the following equation: (*maximum value of alternative – minimum value of alternative*) ÷ *number of levels* = (5 - 1) ÷ 3 = 1.33. Then adding 1.33 to the end of each category. Hence, the response estimates are as follows:

- Low (1.00–2.33)
- Medium (2.34–3.67)
- High (3.68 and higher)

3.2.2. Study variables
The study variables have determined as follows:

i. Independent variables:
 - Gender
 - Nationality
 - Year of study
ii. Dependent variables:
 - They are represented as the responses to the questionnaire's articles within its different domains to determine the satisfaction degree of students in their experience in online learning transition in Saudi Arabia's universities.

3.2.3. Statistical methods and data processing
IBM-SPSS statistical analysis tool has been used to analyze data as follows:

1. For questionnaire's validity and consistency as well as describing the study sample we used the following statistical processes:
 - Pearson coefficient correlation between each domain and its whole articles for the virtual validation of the questionnaire.
 - Cronbach's alpha coefficient for the questionnaire's consistency.
 - Frequencies and percentages for describing the study sample.
2. For results analysis we used the following statistical processes:
 - Means and Standard deviations.
 - T-test for independent samples for identifying the statistical significant differences between means of the study sample estimates, traced to gender, nationality and year of study variables.

4. Conclusion

The aim of this study was to review the most commonly used technologies for the delivery of learning materials to assist the digitalizing of learning during the outbreak of COVID-19, and to view the experience of the most infected countries. Furthermore, this study investigated the major challenges in e-learning. Saudi Arabia was considered as a case study for the effectiveness of distance learning during the 2020 spring semester, where 300 undergraduate students were surveyed about their opinions of distance learning. The results of this study indicated that distance learning was effective in providing the required knowledge to the students during the outbreak of COVID-19.

Our study addressed 2 questions: "*Whether the transition is adequately good for the students*" and "*Are there statistically significant differences at significant level ($\alpha \leq 0.05$) between means of study sample estimates of the*

Table 6
Means and standard deviations and *t*-test according to gender variable.

Domain	Gender	No.	Mean	Standard deviation	t value	Degree of freedom	Significance
The effectiveness LMS as a learning tools $\alpha \leq 0.05$	Male	115	3.863	0.658	101.901	299	.000
	Female	185	3.661	0.611			
The effectiveness of Virtual Classrooms compared to Physical Classrooms	Male	115	3.749	0.688	97.029	299	.000
	Female	185	3.664	0.642			
Ease of understanding the educational material	Male	115	3.822	0.592	104.938	299	.000
	Female	185	3.747	0.642			
Ease of understanding the given assignments	Male	115	3.811	0.583	110.299	299	.000
	Female	185	3.691	0.587			
Overall degree of Questionnaire	Male	115	3.625	0.574	128.004	299	.000
	Female	185	3.574	0.535			

Table 7
Means and standard deviations and *t*-test according to nationality variable.

Domain	Nationality	No.	Mean	Standard deviation	t value	Degree of freedom	Significance
The effectiveness LMS as a learning tools	Saudi	255	3.853	0.639	101.901	299	.000
	Non-Saudi	45	3.695	0.631			
The effectiveness of Virtual Classrooms compared to Physical Classrooms	Saudi	255	3.741	0.636	97.029	299	.000
	Non-Saudi	45	3.679	0.670			
Ease of understanding the educational material	Saudi	255	3.851	0.580	104.938	299	.000
	Non-Saudi	45	3.747	0.639			
Ease of understanding the given assignments	Saudi	255	3.815	0.553	110.299	299	.000
	Non-Saudi	45	3.707	0.599			
Overall degree of Questionnaire	Saudi	255	3.611	0.629	128.004	299	.000
	Non-Saudi	45	3.331	0.598			

Table 8
Means and standard deviations and *t*-test according to year of study variable.

Domain	Year of study	No.	Mean	Standard deviation	t value	Degree of freedom	Significance
The effectiveness LMS as a learning tools	1st	122	3.759	0.637	101.901	299	.000
	2nd	83	3.661	0.633			
	3rd	64	3.716	0.669			
	4th	31	3.622	0.626			
The effectiveness of Virtual Classrooms compared to Physical Classrooms	1st	122	3.810	0.642	97.029	299	.000
	2nd	83	3.651	0.538			
	3rd	64	3.762	0.601			
	4th	31	3.645	0.527			
Ease of understanding the educational material	1st	122	3.699	0.625	104.938	299	.000
	2nd	83	3.795	0.650			
	3rd	64	3.666	0.661			
	4th	31	3.739	0.659			
Ease of understanding the given assignments	1st	122	3.740	0.637	110.299	299	.000
	2nd	83	3.827	0.603			
	3rd	64	3.702	0.592			
	4th	31	3.787	0.579			
Overall degree of Questionnaire	1st	122	3.590	0.649	128.004	299	.000
	2nd	83	3.638	0.585			
	3rd	64	3.549	0.638			
	4th	31	3.486	0.731			

degree of satisfaction traced to gender, nationality, and year of study variables?" Both questions are answered expressing students' satisfaction to what degree they are satisfied; where the first domain "*The effectiveness LMS as a learning tools*" showed the highest impact. This reflects a high degree of satisfaction represented by statistically significant differences at ($\alpha \leq 0.05$) traced back to the gender, nationality, and year of study in all domains and the overall degree, where the differences are in favor of males, Saudis, first year of study in all domains. In some cases, they are in favor of a second year of study in two domains and the overall degree. Hence, male Saudi students are satisfied with the transition towards online learning and specifically the first-year students.

Additionally, the findings concluded that, although the lack of interaction and poor internet connections are factors affecting comfortable and successful learning of physics and mathematics, 63% of students were satisfied with learning management systems; 75% of students found that it was easy to understand the courses materials; and 67% of students found that it was easy to understand assignments and deal with them comfortably. This study recommended and encouraged the universities to digitalize all their learning materials and create material banks including class recordings and to adopt and train staff on online examination systems.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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