

## Teaching mathematics in virtual classrooms during the Covid-19 pandemic: a review from the perspective of students and teachers

By

**Khaled Mohammad Al-Khatib**  
The Saudi Electronic University  
E.mail: [k.alkhatib@seu.edu.sa](mailto:k.alkhatib@seu.edu.sa)

### Abstract

This study aims to identify the perceptions of the joint first year's students at the Saudi Electronic University on teaching mathematics in virtual classes during the Corona pandemic. In addition, it aims to identify the differences in students' perceptions due to the number of semesters they were enrolled in the university during the pandemic when they took math classes and gender. It also tries to recognize the changes in the behavior of students when they attend virtual mathematics classes during the Corona pandemic from the teachers' perspective. The researcher used the descriptive analytical method. Two questionnaires were created and had their validity and reliability confirmed. The student questionnaire was distributed to all the joint first year students who studied the mathematics course during the first and the second semester of the year 2020-2021. 1192 male and female students answered the student questionnaire, while 25 teachers answered the teacher questionnaire. The results showed that students' perceptions of teaching mathematics in virtual classes during the Corona pandemic are generally neutral, and that the perceptions of students who studied mathematics in the second semester were more positive than who studied it in the first semester with a high degree of statistical significance. The results also showed that the male students' perceptions were more positive than the perceptions of female students, and the change in students' behavior when they attended virtual mathematics classes during the pandemic was positive or neutral. Based on the results, a set of recommendations were included.

**Keywords:** virtual classes, teaching mathematics, pros of virtual classes, cons of virtual classes, change in students' behavior, the Covid-19 pandemic.

### Introduction

The global corona virus pandemic of 2019 posed a significant challenge and new opportunity for educational institutions across the globe. Many educational systems - adhering to the instructions of health authorities - followed e-learning methods in providing educational courses in schools and universities. The Kingdom of Saudi Arabia is no exception; it has recognized the necessity of providing all school and university courses through virtual educational platforms, starting in March, 2020 (Al Arabiya Net, 2020).

Utilizing e-learning in the Kingdom of Saudi Arabia is not only a temporary option to avoid the spread of Corona virus, but also a strategic decision, as the Saudi Minister of Education stated that "distance education has become a strategic future option, which requires continuous development and adoption of a culture of change within society to adapt to the e-educational environment regardless of circumstances" (Al-Madina, 2020).

The joint first year at the Saudi Electronic University offers students a set of courses, including the mathematics course, that are normally taught through the blended education

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system that combines e-education and traditional education (Al-Rahimi, 2018), which provides students with both in-person and virtual lectures. In addition, students interact with one another through Blackboard, the educational platform used by the university. As for the spread of Corona virus, the university followed the instructions of the Ministry of Education by providing only virtual classes in addition to the interaction through Blackboard tools.

The mathematics course is among the most difficult courses for many students even before the pandemic, and therefore, teaching mathematics comes with a greater challenge when it is entirely virtual (Trenholm and Beschke, 2020). The study (Al-Khatib, 2018) confirmed that, in normal conditions where students study mathematics through both in-person and virtual lectures, the joint first year students at the Saudi Electronic University struggle in the mathematics course. Recently, with the spread of the Corona virus, teaching mathematics is limited to virtual classes. Were these exceptional circumstances in favor of students who study mathematics or not? Were (they) their pros or cons that dominated this phase?

The current study sheds light on the advantages and challenges that students face when studying mathematics only through virtual classes. It also aims to identify the differences in students' perceptions due to the number of semesters taken during the pandemic and gender. It also seeks to recognize the change in the behavior of students when they attend virtual mathematics classes during the Corona pandemic according to the teachers' points of view.

## **Theoretical framework and previous studies**

### ***Covid-19 pandemic***

It is a global pandemic that has spread throughout most countries of the world, causing a serious illness to millions of people, some of whom died, as no effective vaccine was available in the early days. The pandemic was caused by a virus from the family of Corona viruses called Covid 19.

At the end of the year 2019, Corona epidemic (covid-19) emerged in the Chinese city of Wuhan. On March 11th, 2020, the World Health Organization declared it a global pandemic, and recommended taking some precautionary measures, including social distancing, quarantine, and self-isolation (WHO, 2020). Accordingly, most countries of the world - including the Kingdom of Saudi Arabia - suspended offline education in all schools and universities and adopted online education instead in an attempt to limit the spread of the virus. Many countries closed their borders and institutions, restricted movement, imposed lockdowns, in addition to implementing other measures.

The UNESCO reported on (April 14, 2020) that (1.5) billion learners around the world have been affected due to schools and universities closures in (188) countries (Asiri, 2022).

The Kingdom of Saudi Arabia's Ministry of Education hastened to adopt e-learning at universities through the e-learning management system "Blackboard", while in public education, it has adopted the available supporting platforms that make asynchronous teaching possible, such as "Ain", "Ain Enrichment", and "Future" portals on YouTube, in addition to a number of channels that broadcast scientific lessons in a systematic and scheduled way in order to complete the second semester of the academic year (2019/2020 AD) (Asiri, 2022).

### ***Virtual classes***

Virtual classes are among the most important means of the e-learning system; (Rich et al., 2009) confirmed that virtual classes help students participate in the educational process. In addition, they are geographically unrestricted and can handle large number of students, and provide instant communication and ultimate freedom to choose the time and educational material. They also include a large number of knowledge resources like libraries, encyclopedias and research centers on the Internet. Opening several discussion forums, virtual classes help obtain and analyze feedback as a great source of information.

(Khalif, 2009) defined virtual classes as an principle means to deliver lessons and lectures and provide distance training on the Internet, where the basic elements required by teachers and students are available. He adds that virtual classes are based on the interactive teaching method.

### ***Virtual classes are classified into two types***

First: Synchronous learning, which are classroom-like classes in which the teacher or student uses tools and software at a specific time, that is, teachers and students are required to be present at the same time without being geographically restricted.

Second: Asynchronous virtual classrooms, which are classes that enable students to review and interact with the educational material through the global information network in a self-learning environment. These classes are not restricted to time or place. (Al-Mubarak, 1425)

(Khalafallah, 2017) showed that synchronous virtual classrooms are similar to classrooms, in which the teacher and the learner use tools and software at a specific time. Those tools include the whiteboard, interactive video and (HP Virtual Classroom sentra) Paltalk Talkroom. Virtual classes, then, are the meeting of the teacher and the learner at the same time on the Internet through video and audio conferences, which provide many services such as chat rooms, video and audio live broadcasts, program participation, whiteboard, and others.

Recently, some programs (Webwe, Microcoft teams, Zoom) have appeared on the educational scene and were widely used during the pandemic due to their low cost and ease of use.

As for asynchronous virtual classes, they are defined as traditional e-classes which teachers and learners enter at different times. What distinguishes this type of classes is that it allows all learners to work on the same content without the need to meet at the same time. They use asynchronous software and tools, such as correspondence and chats between learners, e-mails, discussion forums, etc. Asynchronous programs include (Moodle, Claroline, Blackboard, School Gen, Webct) (Khalaf Allah, 2017).

Virtual classrooms are characterized by many features, some of which were mentioned in the study (Khalif, 2009). most importantly, they provide all means of live interaction between teachers and learners traditionally or on the electronic whiteboard. They also enable teachers to make a quick survey of the learners' responses and interactions with the directly displayed lesson. It is possible to organize learners into small groups in interactive rooms with audio and video, enabling the teacher to discuss and analyze the work of any group.

Regarding the obstacles hindering the application of virtual classrooms in the educational process, (Mohammed and Mahmoud, 2010) referred to some of them, including technical problems related to the speed of Internet connection, inexperienced faculty members who need extensive training in e-learning, and the lack of time needed to train teachers to use e-learning and e-content management programs. The absence of a governmental or a private institution to adopt the World Wide Web and internet services is among the biggest obstacles.

### ***Previous studies***

After the spread of Corona virus and the radical changes in the education systems, many researchers studied this exceptional case and shed light on many of its aspects. These studies include:

The study (Morono et al., 2020), which aims to identify the effectiveness of e-education in teaching mathematics to adults in secondary school relative to traditional education. The researchers used the descriptive method in addition to the quasi-experimental method. The results showed that utilizing e-learning has a positive impact on motivation, independence, participation, understanding mathematical concepts, results, and grades. The researchers concluded that e-learning improved secondary school adult students' level in mathematics relative to traditional education. Therefore, this method is considered to be effective when applied on adults.

(Trinholm and Beschke, 2020) also conducted a study aiming to make a review of teaching mathematics entirely online, by clarifying the differences between virtual teaching methods and traditional teaching methods (face to face) through studying education in virtual classrooms (FO) and face to face (F2F) from the perspective of practicing societies. They also compared the current FO virtual teaching practices with the current F2F face-to-face teaching practices in the undergraduate mathematics community. Six major differences were identified to highlight areas of technological and educational development. The study showed the need to improve teaching mathematics in both FO and F2F models.

As for (Babinakova and Bernard, 2020), he conducted a study in which he reviewed e-experiences after the closure of secondary schools due to the Corona pandemic in terms of teaching methods and students' perceptions. This research presents the experiences of secondary school chemistry teachers from Slovakia, especially those who wanted to turn real-class experiences into online lessons because chemistry is based on problems, observations, evidence, and experiments. The results often showed that teachers claim that it can be more efficient if they have the appropriate knowledge, skills, and equipment to deliver virtual lessons. In addition, the research presented the support provided to participants in the IT Academy project, who were previously equipped with the necessary skills and tools to deliver virtual classes. The efforts exerted by teachers to use experiential online practices were described, as well as their students' opinions on the experiences. The results indicated many problems attributed to distance education and confirmed that the transition to e-classes in teaching chemistry was more difficult than it is in other non-scientific subjects due to the nature of experimental chemistry.

(Khalil, et al., 2020) conducted a study that aimed to reveal the perceptions of undergraduate medical students regarding the effectiveness of synchronous e-learning at the College of Medicine and Medical Sciences in Unaizah, Qassim University, Saudi Arabia. The researchers adopted the qualitative research methodology using simultaneous virtual focus group discussions with the help of a discussion guide that consists of seven open-ended

questions. 60 medical students were selected using the maximum variance sampling technique. These students then participated in eight focus group discussions. All interviews were recorded, transcribed verbatim, and analyzed for substantive contents.

The results approached four main themes: (1) educational impact, (2) time management, (3) encountered challenges, and (4) future preferences. Online teaching was well received, and all participants agreed that e-lectures save time, and that their performance has improved due to the abundance of time; however, they indicated that they faced some challenges during lectures and e-exams, such as methodological, technical, and behavioral challenges, as well as difficulties in comprehending the material. Most of the medical students preferred e-learning for the upcoming academic years.

The study (Chavaria Bolanos, et al., 2020) aimed to review and analyze the educational resources available for e-learning in dental schools during the Corona pandemic. It showed the possibility to use e-learning strategies in dentistry in the scientific literature and provided an overview of these opportunities. In addition, the Faculty of Dentistry of the University of Costa Rica's experience was presented, where it was clear that some key elements of the e-learning environment needed to be quickly enhanced and that some processes needed to start. It was necessary to classify the courses according to the possibility of virtual simulation (curriculum analysis and classification), in order to better understand the impact of the pandemic and the negative effects on the student learning process. Teachers also needed more training to apply the hypothetical strategies that they have not used before. In addition, an assessment of students' conditions and needs was conducted. After the activation of the available virtual platforms by teachers and students, researchers concluded that the virtualization process is in a continuous progress even though it was imposed abruptly. This moment actually represents a huge opportunity to immerse in a virtual environment as a teaching/learning experience.

The study (Falud et al., 2015) aimed to identify the impact of using virtual classes developed by researchers on learning mathematics concepts of the secondary education in Nigeria. In addition, it explores how teachers and students evaluate these classes. The researchers used the descriptive and quasi-experimental approaches to answer the three questions of the study and verify its hypothesis. An achievement test for mathematical concepts and two questionnaires were designed to evaluate the virtual classes. The validity and reliability of these tools were also verified. The study was applied to 20 mathematics teachers, and 102 male and female students from two secondary schools. The results of the study showed that virtual classes had a positive impact on students' understanding of mathematical concepts, and that teachers and students positively evaluated these classes.

(Hughes et al., 2014) conducted a study that aims to identify the impact of virtual education on students' achievement in the algebra course and their perceptions of the classroom environment. The researchers designed an achievement test for the algebra course and another tool to identify students' perceptions. The tools' validity and reliability were confirmed. The study was applied to three schools that utilize virtual classes and three other schools that utilize traditional classrooms in three different American states. After a quantitative analysis of the study's data, the results confirmed that virtual classes students had a better academic achievement in the algebra course than traditional classroom student. In addition, they confirmed that the virtual classes students' perceptions of the virtual classes' environment were more positive than the traditional classroom students' perceptions of the traditional classroom's environment.

### ***Commenting on the previous studies***

The previous studies prove the deep interest in studying e-learning, especially when it became a mandatory and, perhaps, the only option for many education systems during the Corona pandemic. Those studies reviews included descriptive, comparative studies and the level of acceptance and effectiveness of virtual learning. Some of them also used both the descriptive and the experimental quantitative approach, while others used the qualitative approach. The current study is distinguished from others by its review of teaching mathematics in virtual classes during the Corona pandemic in the Saudi Electronic University's environment, as this environment is characterized by the adoption of the blended education system, which combines e-education and traditional education. While educational institutions, in general, replaced traditional education with e-education at a distance during the Corona pandemic, the Saudi Electronic University has only replaced in-person lectures with virtual lectures. The current study is reviewing teaching mathematics in virtual classes during the Corona pandemic in this distinguished educational environment.

### ***The study's problem and questions***

This study seeks to answer the following main question: What are the perceptions of first-year students at the Saudi Electronic University about teaching mathematics in virtual classes during the Corona pandemic and its relation to some variables, and what are the changes in students' behavior when attending virtual mathematics lectures during the pandemic?

This main question provokes the following sub-questions:

- 1 What are the perceptions of first-year students in the Saudi Electronic University about teaching mathematics in virtual classes during the Corona pandemic?
- 2 Are students' perceptions of teaching mathematics through virtual classes dependent on the number of classes the students studied during the pandemic?
- 3 Are students' perceptions of teaching mathematics through virtual classes during the Corona pandemic dependent on gender?
- 4 What are the changes in students' behavior when attending virtual math classes during the Corona pandemic?

### ***Importance of the study:***

- 1 Recognizing the most important features of virtual classes and their effectiveness in teaching mathematics by identifying the students' perceptions of them.
- 2 Recognizing the differences between students' perceptions of teaching mathematics through virtual classes, which are attributed to the number of classes the students have studied during the pandemic and to their gender. It leads to increasing clarity in our knowledge about virtual classes, and the extent to which students accept and want to learn through them regardless of the students' different characteristics.
- 3 Recognizing students' behavior while attending virtual mathematics classes is the first step to enhance their positive behaviors and reduce negative ones, which leads to an increasing effectiveness of this education style.

The study's terms:

#### ***1. Corona Covid-19 pandemic***

The researcher defines it as a global health humanitarian crisis caused by Corona virus, Covid-19, which has led to radical changes in all fields, especially educational systems, which replaced traditional education with distance e-learning.

2. Virtual Classes: a virtual class is an online technology that provides an educational environment similar to that of a real classroom, through which the teacher can present lectures with audio, video and writing, and can display video or audio clips. It is characterized by efficient teacher-student interaction (Al-Astal, 2013). In the meantime, the Saudi Electronic University uses the Blackboard educational platform to manage the educational process and provide virtual lectures.

***Virtual classes are classified into two types:***

First, Synchronous virtual classes, which are defined (Yilmaz, 2015) as a form of communication that takes place in online learning environments where students, teachers, and learning groups can communicate with one other at the same time but from different places. Information and communication technologies such as Voice Over Internet Protocol can be integrated in learning management systems to support opportunities for real-time communication within the course content sections of online learning spaces.

Procedurally, the researcher defines it as an interactive learning environment that takes place in the “Blackboard” learning management system, in which the mathematics teacher communicates with his/her students through audio and video twice a week to present the mathematics course. The teacher and students meet at the same time but from different places. Note that all lectures are recorded when they are given and are available to students at any time.

## **Second, asynchronous virtual classes**

It is defined (Yilmaz, 2015) as a form of communication used in online courses that is not restricted by geographical location and does not occur in real time. Students, teachers, and members of the online learning group communicate with each other via ICT supported by content management systems where the process of teaching, learning and sharing ideas can take place via e-mail, discussion boards, and other ICT-enabled platforms that do not require communication to be at the same time and place.

The researcher procedurally defines it as an interactive learning environment that takes place in the Blackboard learning management system, through which the mathematics teacher communicates with his/her students, and the students communicate with one other through discussion groups, file sharing, e-mail messages and other Blackboard tools, in addition to the rest of the curriculum features available on the Blackboard, such as the textbook and the MALPUS Plus to solve exercises.

3The joint first year: It is stated on the website of the joint first year deanship at the Saudi Electronic University that the joint first year is a program offered by the Saudi Electronic University to all first year university students, regardless of their majors, in order to qualify them for university life as it provides them with the skills they need to succeed in their academic and professional life, during which they study five courses: English, mathematics, computer, academic skills and communication skills. Students must pass these courses in order to be able to join their colleges.

### ***Study limitations***

***The current study is limited by the following***

- Spatial limits: This study was conducted in all regions where the Saudi Electronic University is located in the Kingdom of Saudi Arabia: Riyadh, Madinah, Jeddah, Dammam, Tabuk, Jazan, Al-Ahsa, Qassim, Abha, Najran, and Hail.

Time limits: the first and second semesters of the 2020-2021 academic year.

- Human limits: this study was limited to the joint first-year students who are studying the mathematics course in the Saudi Electronic University.
- tool limits: The results of the study were dependent on the extent of accuracy in extracting the validity and reliability indications of the study's two tools (the two questionnaires).

## Study's Methodology

The descriptive analytical approach was used for its relevance to this type of studies; the two study tools were applied to the sample members, and data were collected and analyzed to answer the study's questions.

### *Population sample*

The study's population consisted of all (8354) joint first year students at the Saudi Electronic University who studied mathematics course, Math 001, during the first and second semesters of the academic year 2020-2021. It also consisted of all mathematics teachers (25) who taught the mathematics course to the joint first-year students in that year.

The questionnaire designated for students was sent to all students via e-mail and distributed to all university branches.

As for the study sample, it numbered 1192 male and female students, representing more than 14% of the study's population. They are the students who answered the questionnaire, and whom data was collected for. The number of the student sample members was distributed among the study variables, as shown in the following table:

Variable	Variable levels	Number	Population ratio
Number of semesters	Two semesters	603	51%
	One semester	589	49%
Gender	Males	596	50%
	Females	596	50%

As for the sample of teachers, the study's entire population was made up of 25 teachers.

## Study tools

After reviewing the educational literature related to the subject of the study, the researcher created a questionnaire for the students. It consisted of four axes distributed over 29 items as follows:

- The first axis is related to the educational, academic aspects and the effectiveness of virtual classes in teaching mathematics. It consists of 7 items.
- The second axis is related to the psychological aspects and the positive or negative feelings that teaching in virtual classes gives to students. It consists of 7 items.
- The third axis is related to the technical aspects, the characteristics of the virtual classroom tools, and the challenges students face while using them. It consists of 8 items.

Fourth axis is related to organizational aspects and time management. It consists of 7 items.



The questionnaire included 18 positive items numbered 1, 3, 4, 5, 8, 11, 13, 14, 15, 16, 17, 19, 20, 23, 24, 25, 26, 27.

It also included 11 negative items numbered 2, 6, 7, 9, 10, 12, 18, 21, 22, 28, 29.

Note that the positive item is the one that achieves a positive perception towards teaching mathematics in virtual classes during the Corona pandemic.

The negative item is the one that achieves a negative perception towards teaching mathematics in virtual classes during the Corona pandemic.

The researcher also created a questionnaire for teachers, which consisted of 12 items, some of which express positive behaviors while some express negative behaviors.

To test the instrument, the questionnaires were presented to eight experts specialized in mathematics and teaching mathematics and computer. They teach their courses through virtual classes. Their observation and insight was helpful in ensuring the instrument was sound. Note that in order to answer the items, the respondent can choose one of the Likert scale's five alternatives: strongly agree, agree, neutral, disagree, and strongly disagree.

The students' questionnaire was also applied once to a survey sample consisting of (50) male and female join first-year students who studied mathematics in virtual classes during the Corona pandemic. The Cronbach alpha equation was used to identify the internal consistency coefficient - the stability coefficient-, and the value of the coefficient of stability was Cronbach's Alpha for the resolution as a whole is 91%, meaning that the stability coefficient for the resolution as a whole is 91%. The stability coefficient for the first axis of the resolution was 78%, for the second axis 76%, for the third axis 74%, and for the fourth axis 76%. These values were considered good and appropriate for the purposes of scientific research.

As for the teachers' questionnaire's reliability coefficient, it was calculated using the Cronbach's alpha coefficient on the data of the main sample due to the small number of teachers; it is not possible to take an exploratory sample and a main sample out of 25 teachers. The reliability coefficient of the teachers' questionnaire was 76%.

## **Statistical analysis**

- To answer the first and fourth questions: means, and standard deviations, were found.
- To answer the second and third questions: The Independent Sample T Test- was used to find differences caused by the number of classes and gender.

## **The data analysis procedures**

The researcher undertook the following procedures to conduct the study

1. Designing two data collecting tools and confirming their validity and reliability.
2. Sending the study tools to all members (teachers and students) of the study's population.
3. Collecting completed survey forms.
4. Performing the statistical analysis of the collected data, using the SPSS statistical analysis program.
5. Accessing the results and answering the questions of the study.

6 Interpreting the results and writing down the recommendations.

## The study's results

### *Answering the first question*

The first question states the following: "What are the perceptions of first-year students in the Saudi Electronic University about teaching mathematics through virtual classes during the Corona pandemic?"

The students' responses to the questionnaire were transcribed and entered into the SPSS program as follows:

Strongly disagree: symbolized by number 1

Disagree: symbolized by number 2

Neutral: symbolized by number 3

Agree: symbolized by number 4

Strongly agree: symbolized by number 5

After that, the researcher analyzed the students' answers using descriptive statistics by finding the sums, means, and the standard deviations of each item in the questionnaire.

The following table shows the total of each item in the questionnaire, as well as its the mean, standard deviation, order within the rest of the items, and visualization type. Note that the perceptions are categorized as follows:

The perception is positive if the item's mean is greater than 3.67

The perception is neutral if the item's mean is greater than 2.33 and less than 3.67

The perception is negative if the item's mean is less than 2.33

### *Descriptive Statistics*

No.	Statement	N	Sum	Mean	Std. Deviation	Perception type	Rank
1	Virtual lectures are as convenient for teaching mathematics as in-person lectures.	1192	4694	3.94	1.171	Positive	12
2	Mathematics is a difficult and abstract subject, which makes it hard for me to understand it through virtual lectures.	1192	3726	3.13	1.381	Neutral	24
3	It is as easy to have discussions, dialogues, and interactions during virtual mathematics lectures as it is during in-person lectures.	1192	4535	3.80	1.250	Positive	15
4	Virtual mathematics lectures are interesting and attractive, which increases my willingness to learn mathematics.	1192	4412	3.70	1.229	Positive	16

5	Technical means, such as the whiteboard, available in virtual mathematics lectures increase my ability to understand mathematics.	1192	4872	4.09	1.048	Positive	10
6	I exert a great effort to pay attention and focus during virtual classes.	1192	4612	3.87	1.199	Positive	13
7	I get busy with the phone and other things during virtual lectures, which distracts me and reduces my ability to focus.	1192	3465	2.91	1.387	Neutral	26
8	Limiting the teaching means to virtual lectures increased my sense of responsibility towards my education; it made me more serious and diligent.	1192	4906	4.12	1.009	Positive	9
9	The lack of a competitive environment during virtual lectures reduces my interest and eagerness to learn.	1192	3682	3.09	1.336	Neutral	25
10	I feel less serious during virtual lectures and tend to rest and relax more.	1192	3358	2.82	1.391	Neutral	27
11	I feel less nervous and stressed out during virtual math lectures.	1192	4394	3.69	1.213	Positive	17
12	The teacher's ability to provide psychological support to students decreases in virtual lectures and increases in in-person ones.	1192	3771	3.16	1.350	Neutral	23
13	The virtual learning environment increases students' ability to socialize and communicate with one other and with the teacher.	1192	4567	3.83	1.173	Positive	14
14	The fact that I can eat and drink during virtual lectures makes me more comfortable and eager to learn.	1192	4809	4.03	1.062	Positive	11
15	The course and its content are easily accessible on the Blackboard.	1192	5294	4.44	0.826	Positive	2
16	I face no difficulties accessing and attending virtual lectures.	1192	5197	4.36	0.909	Positive	5

17	The possibility of attending lectures on the mobile phone makes it flexible and easy to attend.	1192	5227	4.39	0.899	Positive	3.5
18	A lot of technical problems hinder attending virtual lectures.	1192	3999	3.35	1.271	Neutral	21
19	Recording lectures enables me to attend them frequently and increases my ability to understand them.	1192	5380	4.51	0.788	Positive	1
20	If I face a problem, the technical support team quickly responds to me to address the problem.	1192	4379	3.67	1.167	Positive	18
21	The Internet connection is often weak, which reduces my ability to attend virtual lectures.	1192	4058	3.40	1.282	Neutral	19
22	I'm face a problem hearing the teacher's voice clearly in virtual lectures.	1192	3275	2.75	1.379	Neutral	29
23	Not having in-person lectures saved the time and effort devoted to going to and from the university.	1192	5184	4.35	0.996	Positive	6
24	Corona circumstances increased my ability to better manage and invest in my time.	1192	5001	4.20	1.018	Positive	8
25	It's easy to be busy with other things during virtual lectures as long as the teacher doesn't see me.	1192	4046	3.39	1.288	Neutral	20
26	Teachers are committed to the lectures' timings; they start and finish on time.	1192	5227	4.39	0.911	Positive	3.5
27	Students are obligated to attend and leave virtual lectures on time.	1192	5135	4.31	0.838	Positive	7
28	My family didn't realize that I was seriously busy learning at home, which increased my family duties at the expense of my homework.	1192	3970	3.33	1.402	Neutral	22
29	Anticipating and following-up with Corona's news distracted my thoughts and reduced my ability to resume my studies.	1192	3340	2.80	1.409	Neutral	28

The above table shows that the items in which the students were neutral towards their content amounted to 11 out of 29 items, all of which are negative items except for item No. 25, which states the following: "It is easy to be busy with other matters during virtual lectures as long as the teacher does not see me." The items of which students expressed a positive perception amounted to 18, all of which were positive items except for item No. 6, which states the following: "I exert a great effort to pay attention and stay focused during virtual classes." The students did not express negative perception of any of the items.

The table also shows that item No.19 had the highest mean: 4.51 out of 5. It states the following: "Recording lectures enables me to attend them more than once and increases my ability to understand." followed by item No. 15 with a mean of 4.44. It states the following: "It is easy to have access to courses and academic content on the Blackboard". Then by item 17 and 26, which had the same mean: 4.39 out of 5. Note that all of these items are positive paragraphs.

The items that had the lowest means are numbered 22, 29, and 10, respectively. Item 22 had the lowest mean: 2.75 out of 5. It states the following: "I face a problem with the teacher's voice level and clarity in virtual lectures," followed by item 29th with a mean of 2.80. It states the following: "The anticipating and following up Corona's news distracted my thoughts and weakened my ability to resume my studies." Then by item 10, which has a mean of 2.82 out of 5. It states the following: "I feel less serious during virtual lectures and tend to rest and relax more." Note that all of these paragraphs are negative paragraphs.

From the above, the most important positive perceptions, arranged in descending order, can be summarized as follows:

1. Recording lectures enables me to attend them more than once and increases my ability to understand.
2. The course and course content are easily accessible on the Blackboard.
3. The possibility of attending lectures on the phone (mobile) increases flexibility and ease of attendance.
4. Teachers are on time; they start lectures and end them at the right time.
5. I do not face difficulties accessing and attending virtual lectures.

On the other hand, here are the least positive perceptions, which are the neutral ones, arranged in descending order:

1. I exert great efforts to pay attention and stay focused during the virtual classes.
2. Weak internet connection often reduces my ability to attend virtual lectures.
3. There are a lot of technical problems that hinder attending virtual lectures.
4. My family did not realize that I was seriously busy with learning at home, which increased my family duties at the expense of my studies.
5. The teacher's ability to provide psychological support to students decreases during virtual lectures and increases with in-person lectures.

***Answering the second question:***

The second question states the following: "Do the joint first-year students' perceptions of teaching mathematics through virtual classes differ according to the number of classes that students study during the Corona pandemic?"

To answer the second question, the researcher calculated the students' total answers to the questionnaire's items after he adjusted the coding of the negative items as follows:

Strongly disagree: symbolized by number 5

Disagree: symbolized by number 4

Neutral: symbolized by number 3

Agree: symbolized by number 2

Strongly agree: symbolized by number 1

As for the positive items, their coding remained unchanged so that the significance of the students' total answers is consistent; the higher the total, the more positive perceptions the respondent has.

The researcher then calculated the arithmetic mean of the students' answers on each axis of the questionnaire and the mean of the questionnaire as a whole.

The following table shows the sum of the students' answers, the arithmetic mean, and the standard deviation of each axis of the questionnaire separately and of the questionnaire as a whole.

No	axis	N	Sum	Mean	Mean from 5	Std. Deviation	Perception type	Rank
1	Academic aspects of education and the effectiveness of virtual lectures in mathematics education.	1192	28166	23.63	3.38	5.298	Neutral	4
2	Psychological aspects and the positive or negative feelings that virtual classrooms cause to students.	1192	29321	24.60	3.51	5.083	Neutral	3
3	The technical aspects, the characteristics of virtual classrooms' tools, and the challenges students face while using these tools.	1192	35601	29.87	3.73	4.970	Positive	1
4	Organizational and administrative aspects.	1192	30647	25.71	3.67	4.561	Positive	2
5	Total	1192	123735	103.80	3.58	17.259	Neutral	

The above table shows that the general mean of students' perceptions of teaching mathematics through virtual classes during the Corona pandemic reached 3.58 out of 5, which reflects a neutral perception. The third axis, which is related to "technical aspects, the characteristics of virtual lecture tools, and the challenges students face when using these

tools," scored the highest mean of 3.73 out of 5, while the first axis, which is related to "educational academic aspects and the effectiveness of virtual classrooms in mathematics education" had the lowest mean: 3.38 out of 5. This mean expresses a neutral perception.

To identify the differences caused by the varying number of semesters that students studied during the Corona pandemic, knowing that there are sample members who studied the mathematics course in the first semester of the year in which they joined the university, meaning that they dealt with the conditions of the pandemic for one semester, while others studied mathematics in the second semester as well. That is, they dealt with the conditions of the pandemic for two semesters.

The researcher found the sum of the students' responses to all paragraphs of the questionnaire to identify the students' perceptions in general, then used the "Independent Samples T Test" to identify the differences caused by the length of time the pandemic persisted when studying the mathematics course.

The results were as follows:

#### *Group Statistics*

<b>Number of semesters</b>	<b>N</b>	<b>Mean</b>	<b>Std. Deviation</b>
Two semesters	603	105.56	17.694
One semester	589	102.01	16.627

#### *Independent Samples Test*

<b>Group</b>	<b>N</b>	<b>Mean</b>	<b>DF</b>	<b>T</b>	<b>Sig.</b>
Two semesters	603	105.56	1190	3.562	0.000
One semester	589	102.01			

The above table shows that the number of students who studied the mathematics course in the second semester during the Corona pandemic was 603, with an arithmetic mean of 105.56, while the number of students who studied the mathematics course in the first semester was 589, with an arithmetic mean of 102.01 out of 145. The calculated (T) value reached 3.562. The fact that the value of the statistical significance is less than 0.05 indicates big differences between the two means.

Therefore, the answer to the second question, which is related to the differences resulting from the varying numbers of classes, will be as follows:

There are statistically significant differences ( $\alpha \leq 0.05$ ) among the positive perceptions of the common first year students at the Saudi Electronic University about teaching mathematics through virtual classes due to length of time the pandemic persisted. These differences are in favor of students who studied the mathematics course in the second semester; that is, when they had to learn in two semesters during the Corona pandemic.

#### *Answering the third question:*

The third question states the following: "Do the common first-year students' perceptions of teaching mathematics through virtual classes differ according to gender?"

To answer the question, the researcher used an "Independent Samples T Test", and the results were as follows:

***Group Statistics***

<b>Gender</b>	<b>N</b>	<b>Mean</b>	<b>Std. Deviation</b>
Males	596	107.1443	17.93816
Females	596	100.4648	15.87844

***Independent Samples Test***

<b>Group</b>	<b>N</b>	<b>Mean</b>	<b>DF</b>	<b>T</b>	<b>Sig.</b>
Males	596	107.14	1190	6.807	0.000
Females	596	100.46			

The table above shows that the number of male students was 596, with a mean of 107.14 out of 145, while the number of female students was 596, with a mean of 100.46. The calculated (T) value was 6.807. The fact that the value of the statistical significance is less than 0.05 indicates big differences between the two means.

Therefore, the answer to the third question, which is related to the differences caused by difference in gender, will be as follows:

There are statistically significant differences ( $\alpha \leq 0.05$ ) in the positive perceptions of the common first year students at the Saudi Electronic University about teaching of mathematics through virtual classes due to the difference in the student's gender. These differences are in favor of males.

***Answering the fourth question:***

The fourth question states the following: "What are the changes in students' behavior when attending virtual mathematics classes during the Corona pandemic?"

To answer the question, the researcher entered the teachers' answers to the questionnaire designated for them into the SPSS program as follows:

Strongly disagree: symbolized by number 1

Disagree: symbolized by number 2

Neutral: symbolized by number 3

Agree: symbolized by number 4

Strongly agree: symbolized by number 5

The researcher then analyzed the teachers' answers using descriptive statistics by finding the sums, arithmetic means, and standard deviations of each item of the questionnaire.

The following table shows the total, arithmetic mean, standard deviation, order of each paragraph within the rest of the items, and the type of change.

The above table shows that the items with the highest means are the first, seventh and second. The first item had the highest mean: 4.24 out of 5. It states the following: "more committed to attending lectures and less frequently absent." It is followed by the seventh item, which has a mean of 4.04. It states the following: "communicating with the teacher more by e-mail and other communication tools". The second paragraph has a mean of 3.80. It states the following: "more eager to attend the lecture on time."

As for the items with the lowest means, they are the tenth, fifth and twelfth. The tenth item had a mean of 3.00 out of 5, and it states the following: "more bored when attending the



lecture.” As for the fifth paragraph, it had a mean of 3.12. It states the following: “more attentive to the teacher while explaining”. The twelfth paragraph had a mean of 3.20 out of 5. It states the following: “more dependent on themselves than they are on the teacher in understanding the material.”

### *Descriptive Statistics*

No.	Statement	N	Sum	Mean	Std. Deviation	Type of change	Rank
1	More committed to attending lectures and less frequently absent.	25	106	4.24	0.879	Positive	1
2	More eager to attend lectures on time.	25	95	3.80	0.817	Positive	3
3	More eager to attend the whole lecture.	25	89	3.56	0.961	Neutral	5
4	More eager to solve assignments and exercises.	25	93	3.72	0.843	Positive	4
5	More attentive to the teacher while explaining.	25	78	3.12	1.092	Neutral	11
6	More participating in dialogue and discussion during the lecture.	25	81	3.24	1.052	Neutral	9
7	Communicates more with the teacher by e-mail and other communication tools.	25	91	4.04	0.908	Positive	2
8	More willing and motivated to learn mathematics.	25	85	3.40	1.080	Neutral	6.5
9	More willing to ask the teacher questions during the lecture.	25	85	3.40	0.913	Neutral	6.5
10	Less bored while attending the lecture.	25	75	3.00	1.041	Neutral	12
11	More indifferent, - as in logging in to the lecture and then getting busy with other things -.	25	83	3.32	1.145	Neutral	8
12	More dependent on themselves rather than on the teacher to understand the material.	25	80	3.20	1.041	Neutral	10

The most important positive changes in descending order can be summarized in the following behaviors:

1. More commitment to attending lectures and less absenteeism.
2. More communication with the teacher by e-mail and other communication tools.
3. Higher eagerness to attend the lectures on time.
4. Higher eagerness to solve homework and exercises.

The table does not show any negative changes; the change in behavior is either positive or neutral.

## Discussing the results:

### *Discussing the results of the first question:*

The first question states the following: "What are the perceptions of first-year students at the Saudi Electronic University about teaching mathematics through virtual classes during the Corona pandemic?"

The results showed that the students' perceptions were classified into only two levels; either positive or neutral. The most prominent of these positive perceptions are:

1. Recording lectures enables me to attend them more than once and increases my ability to understand.
2. The course and course content are easily accessible on the Blackboard.
3. The possibility of attending lectures on the phone (mobile) increases flexibility and ease of attendance.
4. Teachers are committed to the lectures' timings, they start and end the lecture at the right time.
5. I do not face difficulties accessing and attending virtual lectures.

What explains these results is that students were able to recognize the advantages of teaching mathematics through virtual classes during the Corona pandemic because of this system's features, such as recording lectures, which allowed students to review the lectures frequently to increase their understanding of the course, and level of flexibility, which allowed students to attend virtual classes from anywhere - without having to go to and from the university - even on their mobile phones, in addition to many other positive features mentioned in the questionnaire. This result is consistent with the results of many studies that examined the reality of teaching in virtual classes during The Corona pandemic, such as (Khalil, et al., 2020) and (Chavaria Bolaños, et al., 2020). It is also consistent with studies that examined the advantages of teaching in virtual classrooms in general, such as (Morono et al., 2020) and (Falud et al., 2015). Since teaching in virtual classes has many positive advantages under normal circumstances, students tend to recognize even more of these positive advantages during the Corona pandemic, when teaching in virtual classes is the only option for countries and educational institutions to resume the educational process while preserving the health of students.

The results also showed that the least positive perceptions, which are neutral, can be arranged in the following descending order:

1. I exert great efforts to pay attention and stay focused during the virtual classes.
2. Weak internet connection often reduces my ability to attend virtual lectures.
3. There are a lot of technical problems that hinder attending virtual lectures.
4. My family did not realize that I was seriously busy with learning at home, which increased my family duties at the expense of my studies.
5. The teacher's ability to provide psychological support to students decreases during virtual lectures and increases with in-person lectures.

What explains these results is that when replacing traditional education with distant e-education, it becomes normal for countries, educational institutions, teachers, and students to face many difficulties and challenges, which will reduce the positive aspects of the educational process. In the Saudi Electronic University, however, the transition during the Corona pandemic was not a transition from traditional education to e-learning; instead, it was

a transition from blended learning to e-learning; that is, e-learning and utilizing virtual classes is an integral part of blended education. Therefore, the transition from blended to electronic education was not difficult for the university, teachers, and students. Replacing in-person classes with virtual classes was the only change that took place, knowing that blended education includes both in-person and virtual classes. This shows that there are no negative perceptions of teaching mathematics through virtual classes. Despite that, we can explain the presence of neutral perceptions (neither positive nor negative) about teaching mathematics through virtual classes by considering the positive features of in-person classes which the students have missed during the Corona pandemic when studying mathematics only through virtual classes. This result is consistent with other studies that confirmed the presence of some difficulties and challenges when teaching through only virtual classes such as (Trenholm and Beschke, 2020) and (Babinakova and Bernard, 2020).

These results can be interpreted as the following: the students might have actually faced some difficulties and challenges while studying mathematics through virtual classes only, but they were able to understand and realize the importance of preventive measures during the Corona pandemic. Accordingly, they did not consider these difficulties and challenges as negative aspects of virtual education; instead, they considered them to be necessary precautions to endure the pandemic, which made the perceptions appear neutral.

***Discussing the second question:***

The second question states the following: "Do the common first-year students' perceptions on teaching mathematics through virtual classes differ according to the number of classes that students have studied during the Corona pandemic?"

The results show that the perceptions of students who studied the mathematics course in the second semester during the pandemic are more positive than those of students who studies the mathematics course in the first semester during the pandemic. The difference in perceptions' level of positivity was with a statistical significance. This can be explained by the fact that students, after enduring the pandemic for two semesters, became more understanding and aware of the importance of precautions during the pandemic, most important of which is social distancing, which requires pausing the in-person classes, especially that the Kingdom of Saudi Arabia's health system did not suffer from what many other health systems in some countries suffered from. Therefore, they were more convinced with the necessities of such precautions, which increased their perceptions' positivity. Another way to explain the results is through considering that students might have adapted more to studying mathematics through virtual classes without having in-person classes. The perceptions of students who studied mathematics in the second semester are more positive than those of students who studied mathematics in the first semester.

***Discussing the third question:***

The results show that the male students' perceptions of teaching mathematics through virtual classes were more positive than those of female students with a statistical significance. This can be explained through the fact that more than 82% of students participating in the study are over 20 years old, which means that male students are probably employers or employees, spending most of their time outside their homes. Therefore, the pandemic offered them opportunities to enjoy and be comfortable with staying home. In addition to that, studying through virtual classes saves them a lot of time that is usually spent going to and from the university. It has even enabled them to attend their classes while at work, if necessary. Therefore, the precautions have allowed them to achieve their educational goals with less time and effort. That is why their perceptions were more positive than those of

female students. On the contrary, most female students spend most of their time at home, so going to university is a good opportunity for them to socialize, break the routine, and enjoy with their friends. Social distancing precautions have deprived them of this opportunity; therefore, their perceptions of teaching mathematics through virtual classes were less positive than those of male students.

***Discussing the fourth question:***

The fourth question states the following: “What are the changes in students’ behavior when attending virtual mathematics classes during the Corona pandemic?”

The results showed that the most important positive changes in descending order can be summarized in the following behaviors:

1. More commitment to attending lectures and less absenteeism.
2. More communication with the teacher by e-mail and other communication tools.
3. Higher eagerness to attend the lectures on time.
4. Higher eagerness to solve homework and exercises.

The results showed no negative changes; they were either positive or neutral.

It seems that these results are very logical as the overall changes in behavior indicate the students' willingness to learn mathematics and pass the course with the best results. After the in-person lectures were cancelled the students' most essential opportunity to learn mathematics with the virtual lectures being only supportive, virtual classes became their only opportunity during the Corona pandemic. Therefore, the students' keenness to learn through virtual classes increased, which explains why students invest in them in the best ways possible to achieve their educational goals from the mathematics course.

***Based on the study's results, the researcher recommends the following:***

1. Increasing the educational institutions' interest in e-learning in general and virtual classes in particular by enhancing its strengths and overcoming its weaknesses.
2. Emphasizing that e-learning is a strategic option for countries and educational institutions to prevent the educational process from being influenced by any exceptional circumstances.
3. Working to provide appropriate environments and necessary tools to reduce challenges that prevent e-learning's goals from being fully achieved.
4. Spreading the e-culture in the community and working on raising awareness of its importance and the advantages it provides so that students become more accepting towards this system of education.

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