

## Does distance teaching of science and mathematics meet teachers' expectations?: Science and mathematics teachers' perceptions, attitudes, and challenges of distance education

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### Abstract

The most important benefits appear in ability of distance education (DE) to face challenges related to classroom education, as student's absence from lesson does not affect it. DE also reduces waste of time and money to reach school or university and enhances aspects of self-responsibility. When student is self-disciplined, she is given a greater opportunity to expand sources of knowledge. This study aimed to explore to which extent Jordanian science and mathematics teachers satisfied towards DE and identify their attitudes and challenges they faced considering some variables: teachers' gender, region, school stages they teach, experience, knowledge in technology skills, and specialization. Study population consisted of all Jordanian teachers in public schools from all regions in Jordan. The study sample included 499 male and female teachers. We developed a study questionnaire, which contained 27 items. After examining its validity and reliability, it was spread out electronically according to snowball method. The study showed several results, science and mathematics teachers' satisfaction of DE was moderate, and there were no statistically significant differences in value of importance of DE for all variables except teachers' competence of information and communications technology (ICT) knowledge and skills. The results indicated that level of Jordanian teachers' attitudes to DE was moderate, and there is a difference in their attitudes towards DE in favor of teachers who master ICT knowledge and skills. The results showed a difference in teachers' attitudes according to their specializations for benefit of scientific track while there were no statistically significant differences for rest of the study variables. Finally, the results pointed out that there are many challenges facing teachers in DE, which came in strong category. The study results presented no statistically significant differences regarding challenges teachers faced in DE in all study variables. The study suggests training teachers on employing DE strategies effectively and implementation of digital applications and educational media. Also, it suggests redesigning academic content according to DE models and theories, designing assessment strategies and tools to measure achieving of the learning outcomes, providing schools with infrastructure of DE, and providing free and sufficient internet services and computers or laptops for teachers.

**Keywords:** distance education, science and mathematics teachers, teachers' perceptions, teachers' attitudes, challenges of distance learning

### INTRODUCTION

Education is considered the main engine in the prosperity and development of civilizations in addition to being the core of measurement in the growth and

development of societies, and the level of education among individuals represents the essential basis for civilizational progress, as it constitutes a fundamental difference between advanced societies and backward societies. It is worth noting that education has developed

### Contribution to the literature

- This research focused on science and mathematics teachers, considering these subjects to be among the most important and most difficult subjects that students struggle to learn, especially in exceptional circumstances.
- It aimed to identify the degree of appreciation of science and mathematics Jordanian teachers for the importance of distance education, and to identify their attitudes and the challenges they faced in the light of some variables such as: the gender of the teacher, the region in which he works, the stage he teaches, the number of years of experience, knowledge in information technology skills, field of specialization, and identification of the most important challenges and problems encountered during e-learning.

in several forms and patterns, including distance education (DE), which emerged to deal with urgent needs and critical conditions by taking advantage of successive developments with a rapid pace of growth and different forms and patterns, the most important of which is the technical development associated with the educational system (Al-Mousa, 2014) through creating digital platforms to facilitate DE process at a time when it is difficult for students to go to educational institutions (United Nations Educational, Scientific and Cultural Organization [UNESCO], 2017).

Researching in the attitude towards the use of e-learning in education and its importance is more important than knowing the applications of this network in design, and that the reason for the reluctance of some teachers about the use of the Internet in education is due to a lack of awareness of the importance of this technology: Firstly, the inability to use it secondly, and thirdly not using the computer, and the solution is it is necessary to develop training programs on how to use computers in general, first. Secondly, using the Internet in particular, and on how to use technology in education third (Al-Shunnaq & Doumi, 2010).

One of the most important necessities that compel contemporary societies discontinuing formal education and resorting to DE are wars and the spread of epidemics and infectious viruses, which threaten the life of humanity. Whoever follows global affairs finds that the emerging coronavirus (COVID-19), which evolved rapidly and resulted in the appearance of many mutations that formed a threat to the life of all humanity has misled many vital sectors in the world, the most important of which is the educational sector. Accordingly, those countries, including the Hashemite Kingdom of Jordan, were called on to resort to DE to preserve the lives of students and prevent them from gathering and spreading the epidemic more than it already is (Saavedra, 2020). Within Jordan's keenness in parallel with the concern for citizen health during the COVID-19 pandemic, the Ministry of Education launched a platform aimed at training teachers and school leaders on a set of insights and skills that enable them to sustain DE process, provide the necessary support for their students, interact with them, send assignments to them and evaluate them continuously in

order to provide education for all while giving multiple options that commensurate with the needs and capabilities of learners without needing to be bound to a specific place and time. While we find many interested in education and learning expressing their satisfaction with the efforts made, others point to many weaknesses and challenges with a low level of contentment; therefore, this study came to identify the reality of education in light of the COVID-19 pandemic from the point of view of science and mathematics teachers in Jordan.

### Research Problem & Research Questions

At the beginning of the year 2020, the entire world was surprised by the emergence of a rapidly spreading virus known as COVID-19, which called on the countries of the world to quickly take various preventive measures and close vital sectors in the country. The most important of which is the education sector at its various school and university levels. Approximately 1.6 billion children have dropped out of education, which is about 89.0% of the students enrolled in schools in the world. It is known that the Jordanian student spends up to 1,000 hours per year learning in schools (Abdullah, 2020; Al Salman et al., 2021). Therefore, the role of schools and regular classes in preparing students in various fields (behavioral, cognitive, skillful, and social) is highlighted here. As we know, the delay in educating students will affect the students themselves, their parents, and their teachers alike, which necessitated the Jordanian Ministry of Education to think of an alternative and new educational method represented by using DE to rectify the current situation. The Jordanian Ministry of Education has invested in communication means such as the television and some educational platforms like Darsak platform, which displayed educational materials for three online education service providers such as Abwab, EdraaK, Jo Academy, and Noor Space platform, which came to complement what Darsak platform offers in terms of the possibility of communicating and interacting with students providing them with feedback and evaluating their learning (Ministry of Education, 2021).

Although there are many studies that have emphasized the importance of an interactive learning

environment through DE that provides what students can learn in regular schools, there are many challenges and difficulties that still constitute an obstacle in the optimal use of DE environment and make it an interactive environment that motivates students for self-learning, creativity, exploration and research. Among these challenges is the extent to which teachers are prepared and qualified for DE and the integration of digital technology into education. In addition, their possession of the material requirements necessary to achieve this on the one hand, and on the other hand their attitudes and convictions towards leading such a new role in education starting with being responsible for designing the teaching content in a way that is appropriate to the distance learning environment leading to a change in their role from traditional teaching to the role of a guiding teacher, self-learning, creativity and innovation encourager. The Jordanian Ministry of Education has emphasized that "the involvement of teachers in DE process is important and necessary, and they are a major partner in the educational process, even if it differs in its form" (Bawaneh, 2020, 2021; Mazher, 2020).

On the other hand, this study focuses on the perspectives of Jordanian science and mathematics teachers and the challenges they faced in teaching remotely during the pandemic period. This is because these courses have a different nature, and direct teaching in the classroom may be more suitable than it is in other subjects.

Despite the continuous efforts in the professional development of the Jordanian teacher, there are many questions including: Are the teachers really prepared for the new concept of DE? Can this experience be considered DE, or have we been put in front of an emergency plan in the form of DE? What were the teachers' attitudes during the implementation of that emergency plan?

Therefore, it was necessary to conduct this research to find out the knowledge of teachers, the challenges they face, and their attitudes towards DE as an emergency alternative in order to predict in the future how such challenges can be overcome as well as benefit from experience by determining what needs to be done to support teachers in adopting DE in a positive and effective way during and after the end of this ordeal that afflicted the whole world.

This study aimed to answer the following questions:

1. **First question:** To what extent do science and mathematics Jordanian teachers appreciate the importance of DE from their point of view?
2. **Second question:** Does science and mathematics Jordanian teachers' degree of appreciation differ with the difference of some variables (gender, region, stage of taught, experience, possession of

information and communications technology [ICT], and the teacher's specialization)?

3. **Third question:** What is science and mathematics Jordanian teachers' attitudes level towards DE?
4. **Fourth question:** Does science and mathematics Jordanian teachers' level of attitudes differ with the difference of some variables (gender, region, stage of taught, experience, possession of ICT, and the teacher's specialization)?
5. **Fifth question:** What level of challenges did the science and mathematics Jordanian teachers face in DE?
6. **Sixth question:** Does the level of challenges science and mathematics Jordanian teachers faced differ according to the difference of some variables (gender, region, stage of taught, experience, possession of ICT, and the teacher's specialization)?

### Importance of the Study

Artificial intelligence (AI) in e-learning has begun to take different forms in the past couple of years. Educators and AI experts are working to provide the best experience for teachers and students alike by integrating AI into the classroom. By using AI software in the classroom, you will save yourself the energy and time wasted on planning and grading tests. Learning management platforms are usually powered by AI. They can automatically create tests, classify them, and create reports for each student that are sent to the guardian and saved among the student's files. Teachers no longer care about these administrative tasks that consume their valuable time.

The importance of this study lies in the fact that it is related to the employment of DE in exceptional circumstances through the teaching and learning platforms adopted by the Jordanian Ministry of Education. It aimed to identify the degree of appreciation of science and mathematics Jordanian teachers for the importance of DE, and to identify their attitudes and the challenges they faced in the light of some variables such as the gender of the teacher, the region in which he works, the stage he teaches, the number of years of experience, knowledge in information technology skills, field of specialization, and identification of the most important challenges and problems encountered during e-learning.

The researchers hope to provide recommendations for those in charge of designing educational materials, decision makers in the Jordanian Ministry of Education, educational supervisors, teachers, and parents. always Taking these suggestions into consideration in planning and continuous readiness to facilitate student learning and make teaching, e-learning and distance learning an essential part of the educational process even after the end of the COVID-19 pandemic.

## Limitations of the Study

1. Jordanian teachers of science and mathematics.
2. This study was limited to the second semester of the academic year 2021/2022.
3. The results of the study were determined in the light of the degree of validity and reliability of the study tool used.

## Operational Definitions

### *Distance learning*

It is the system approved by the Jordanian Ministry of Education in light of the COVID-19 pandemic to provide science and mathematics content for students electronically through various platforms such as Darsak, Microsoft Teams, Noor Space, and Zoom, in addition to television stations and social networking sites.

### *Distance learning challenges*

The resources (logistics, technological skills, educational material design, or accessibility of educational platforms) that hinder or limit DE.

### *Attitudes*

A state of mental willingness of science teachers organized through their previous experiences on their convictions of the effectiveness of using distance learning.

## THEORETICAL FRAMEWORK & PREVIOUS STUDIES

There is no doubt that DE has taken on a large scale according to the need in many countries of the world to facilitate the education process and the access of knowledge to all people without having to travel long distances to obtain knowledge. At the present time, DE has become an absolute and indispensable necessity as a lesson learned from the spread of COVID-19, which affected the entire global system and all its vital sectors, especially education. It became necessary to carry out the inevitable shutdown and curfew, and it even came to more brutal measures represented by the home quarantine for many peoples of the world to avoid contact that might lead to the spread of the epidemic. According to the necessity of continuing the educational process and not interrupting it for students, the most important option was to resort to DE (Bawaneh & Moumene, 2020; Malkawi et al., 2021). This part of the study discusses DE considering the COVID-19 pandemic, through the following dimensions.

## What is Distance Education & Its Most Important Technologies?

DE is one of the most prominent features of the modern era due to its spread among societies in general; accordingly, we cannot overlook the importance and benefits of the facility of learning it provides, the speed of communication, access to educational curricula data, and the ease of communication between the teacher and the students. Thus, DE has achieved widespread fame in all contemporary societies (Malkawi et al., 2021; Shery, 1995). According to the disagreements between researchers and academics about the concept of DE, and the challenges it faces, it has been difficult to find a common definition for it. However, the distance learning process involves the facility of information and various skills transmission in the frame of the educational process, and it enables students to gain different educational skills using modern means of communication including multimedia and specialized technical programs that link the learner and teacher to raise education efficiency and make the most of the educational process (Tony, 2005).

In this regard, we find Sulaiman (1995, p. 129) defining DE as "an attempt to deliver the educational service to the individual, where he lives or works, and it is directed in particular to groups who have a desire for education and are able to do so." While Al-Sharhan (2014) refers to it as an educational system based on the idea of delivering the educational material to the student through various technical communication media, where the learner is far and separate from the teacher.

Meanwhile Sherry (2004) worked on collecting the common factors for the different concepts of DE, which can be summarized, as follows:

1. Separation between the teacher and the learner spatially, or temporally, or both.
2. Success of DE depends more on the interaction of the learner than it does on the teacher.
3. Communication between the teacher and the learner takes place through modern technological means, whether visual, audible, printed, or all.

## Distance Education in Exceptional Circumstances- Emerging COVID-19 Pandemic as an Example

DE is one of the most prominent features of the modern era, and it has been clearly linked to the aspects of life including technical and informational developments described as the rapid pace of its speedy development in the entire world. In light of what the World Health Organization (2020) indicated that this epidemic will not end easily from the world, and the world's call to coexist with this pandemic (Arabic News, 2020), it was necessary for countries to adopt DE curriculum as it is the most present hope in preserving the scientific process in all countries of the world

(Mashala, 2020) being considered a more efficient and effective way closer to the interest of students whose interest has become mostly associated with the various electronic communication means, and dealing with automatic devices such as computers, smart phones, etc. (Mashala, 2020).

On the other hand, it may be appropriate to address the existence of many challenges that hinder DE, which can be summarized, as follows:

1. The Internet is not an element available to all people: The Internet is the most important means in conducting DE process as it is the means of communication and the channel of information transmission between students and faculty members. Therefore, without the presence of the Internet for some, or even the weakness of the Internet may lead to a weakness in the educational process from a distance. Despite the wide spread of the Internet throughout the world, which has become the most essential element in the lives of many people, there are many peoples or a few students who do not have this most essential element, which is considered the biggest challenge for DE.
2. "The monitor does not replace the teacher": The teacher who deals with the students directly cannot be compensated by a physical screen in front of the student because the interaction that lies in the classroom environment by the participation of students, the competition of students among themselves during participation, events and academic activities, all no longer exist; consequently, this will be patently reflected on the student's activity and educational ability (Jinga, 2020).
3. The teachers are not available at any time, and parents are not teachers: In many cases the students resort to the teachers at any time during school hours to discuss a matter with them, but this is not available in DE. Also, many parents are unable to support their children as teachers.
4. Lack of an atmosphere for proper learning at home: In many cases, the student may lose the appropriate environment for learning in light of distance learning techniques due to several reasons most notably of which is the absence of the quiet academic atmosphere that he/she used to enjoy in the school and the lack of the proper number of hours for studying. In some cases, the large number of family members in a small house contributes to distracting the student's mind during DE (Saati, 2020).

In light of the foregoing, the researchers believe that DE represents the most present and most important hope for students who have dropped out of their schools as it provides all possible conditions for the delivery of

science and knowledge to all students, not to mention the existence of the elements of DE like computers and the Internet that have become widely available all over the world.

However, DE is still criticized by some parties who pointed out the obstacles and challenges facing DE, and yet these obstacles and challenges did not result from DE techniques but rather from the conditions in which people live from poverty and the inability to provide the necessary capabilities to start DE in addition to other challenges.

The researchers believe that the hopes DE holds for students are much greater than the challenges it entails considering the COVID-19 pandemic, which leads us to the possibility of making DE more advanced and suitable for many students around the world and the possibility of making the most of its effective components.

### Previous Studies

It was possible to view relevant scientific studies and sources related to the subject of the current study. The following is a brief statement of the most important of these studies.

In the study of Nasser and Abouchedid (2000) entitled "Attitudes and concerns about distance education: A case study from Lebanon", it aimed to research the attitudes of teachers and school principals towards the value and importance of implementing a DE program in Lebanon. The study surveyed seven school principals and 112 teachers. The results of this study showed that the attitudes of school principals were negative regarding the possibility of DE meeting the training needs of schoolteachers. They described the cost of training teachers and purchasing distance learning technologies as unimaginable.

On the other hand, teachers showed a more positive view of DE. Although more than 50.0% of them reported little knowledge of the features of DE, they reported their interest and willingness to make the necessary effort to learn about innovative technologies and practices.

Raes et al. (2020) studied the effect of using hybrid and virtual classrooms on the degree of students' integration, interaction, and performance. Although hybrid and virtual classes are promising and support students' achievement, since they provide flexibility and freedom in choosing the time and place, they prefer to attend lessons, the results showed that the students' motivation and integration with colleagues and teachers were extremely low in virtual learning. This may be since the current generation is digital by nature and is always looking for modern, fast, advanced applications that contain fun, achieve benefit, and increase the interaction of all the parties to the educational and learning process. This is considered, in the study's

opinion, one of the challenges facing the educational process.

The study of Zhou et al. (2020) emphasized the importance of e-learning, DE, and mobile phone use. The study conducted in China considered that online learning is more than a complement to school education, and that the COVID-19 pandemic led to the dissemination of the culture of e-learning and distance learning as an alternative solution to continue the educational learning process considering the pandemic and the shutdown of schools.

In the study of Sintema (2020), which aimed to study impact of the COVID-19 pandemic on the performance of twelfth grade students from the point of view of STEM (science, technology, engineering, and mathematics) teachers of science, technology, engineering, and mathematics in Zambia, educators in Zambia indicated that due to the country's limited technological resources and the difficult stage represented by the outbreak of COVID-19 and the early and sudden closure of schools that there would be a decrease in the success rate of secondary school students in the national tests for this year. In the study of Mailizar et al. (2020), which aimed to explore the views of mathematics teachers in Indonesia about the challenges facing education and e-learning during the COVID-19 pandemic. This pandemic deprived more than 45 million male and female students and more than three million teachers from schools, and they became dependent on e-learning and teaching as an unprecedented experience for them in Indonesia and the lack of experience and infrastructure necessary for this type of learning. The results indicated that the challenges were classified under four basic elements: the teacher, the student, the school, and the curriculum. The results also showed that the biggest obstacles are related to the student, followed by the school and the curriculum while the study did not show real obstacles associated with the teacher. The study aimed to investigate the students' attitudes of basic and secondary schools in Jordan towards distance learning, the challenges they faced, and their suggestions to overcome them from their point of view. The study population included all Jordanian male and female students from all regions and for the various educational stages. The sample size of the study was 746 male and female students. The data was collected using a questionnaire that the researchers constructed and ensured its validity and reliability. The snowball method was used to spread out the questionnaire link. Appropriate statistical analyzes were performed to answer study questions such as means, standard deviations, frequencies, and percentages. The study concluded that

Bhat et al. (2021) did a systematic review of online learning during the COVID-19 crisis in India educational institutions. And they found that they are currently grounded only in traditional methods of learning, they

follow the traditional arrangements of face-to-face learning methods in classroom. Although many educational institutions at various levels (colleges, schools, and universities) have also started blended learning, still most of them are stuck with the procedures, which are yet to rejuvenate. The sudden burst of coronavirus (SARS-CoV-2) shook the entire world and has interrupted all facets of the daily lives. This situation challenged the education system across the world and forced educators to shift to an online mode of teaching overnight.

Many academic institutions that were earlier indisposed to change their traditional pedagogical approach had no option but to shift entirely to online teaching-learning. This study elucidates the importance of online learning and elaborates on the opportunities and challenges of e-learning modes in the time of crisis. The research piece sheds some light on the growth of IT-enabled tools during the time of the pandemic. In concluding interpretations this research article places suggestions for academic institutions on how to deal with challenges associated with online learning.

Al-Salman and Bawaneh (2021) found that the average attitudes of Jordanian students towards distance learning came within the intermediate category, while the average of the challenges were within the weak category, which means there are many difficulties faced. The study also indicated that there are many challenges for distance learning in Jordanian schools represented in the availability and speed of internet services, and content design according to distance learning, as well as the need to consider the diversity of students and the method of delivering the material in addition to the importance of training both teachers and students on the mechanisms of using learning platforms. This supported by Al-Rumahi's (2022) study, which aimed at revealing challenges of digital learning (distance learning) considering the COVID-19 pandemic's era changes from students' point of view the study population consisted of all students in the eleventh grade of post-basic education (11-12) in the Sultanate of Oman for the academic year 2020/2021. The study sample consisted of 168 students. The study's results showed that the most important challenges, from students' point of view, were the network that related to the "Internet" and devices and their accessories that used for digital learning came to a high degree and the eleventh - grade students' attitudes level towards digital learning was neutral. The study's results also showed that there were no statistically significant differences towards digital learning according to the subject variable (literary subjects/scientific subjects/individual skills subjects).

#### **How is This Study Different from Previous Studies?**

The current study differs from previous studies in several aspects, the most important of which is that the

current study combined DE for science and mathematics in Jordan in particular during the COVID-19 pandemic, and how DE can work on the continuity of educational life of scientific subjects that most educators unanimously agree on the importance of teaching them in the presence of students. On the other hand, the study is expected to suggest some practices that would raise the efficiency of teaching science and mathematics remotely and develop workable solutions for the challenges faced by teachers of these subjects in exceptional circumstances.

## METHOD & PROCEDURES

### Methodology

To achieve the objectives of the study, the researchers followed the analytical descriptive method by employing descriptive statistics such as calculating means, standard deviations, and the rank of each item within each of the dimension of the study's tool, then comes the role of inferential statistics using the one-way analysis of variance (ANOVA) test.

### Study's Population & Its Sample

The study's community is made up of all science and mathematics Jordanian teachers who work in public schools for the academic year 2021/2022. The questionnaire was built and made sure of its sincerity and steadfastness then designed electronically through the account of one of the researchers to apply (question-pro). The study questionnaire was sent as an electronic link through the various social networking sites using the snowball method, every colleague sends it to the groups on his mobile phone, and so it was sent to all the students in all regions of the Kingdom. According to Gay and Airasian (2003), all the individuals in the defined population have equal and independent chance of being selected. The study's sample was distributed according to its variables, as shown in **Table 1**.

It is noted from **Table 1** that the sample of the study included 499 male and female teachers, 381 (76.4%) of whom are females, and 118 (23.6%) are male teachers distributed over three regions: The North Region (42.3%), the Central Region (39.9%), and the Southern Region (17.8%). As for the age stage taught by teachers, the percentage of teachers teaching the low basic stage (from the fourth grade to the seventh grade) is 45.5%, while the percentage of those teaching the high basic stage (from the eighth grade to the tenth grade) is 28.7%, and finally the percentage of secondary school teachers being the lowest is 25.9%. As for the number of years of teachers' experience, it was divided into four levels: the first level (one-five years) and their number are 99 out of 499 representing 19.8%, the second level (six-10) representing 27.7%, and the third level (11-15) with a rate of 22.8%. As for the fourth level, it was for those with

**Table 1.** Description of study sample of teachers according to study variables

Variables	n	P (%)	CP (%)
Gender			
Male	118	23.6	23.6
Female	381	76.4	100
Total	499	100.0	
Region			
North	211	42.3	42.3
Middle	199	39.9	82.2
South	890	17.8	100
Total	499	100.0	
Stage			
Low basic (4-7)	227	45.5	45.5
High basic (8-10)	143	28.7	74.1
High school (11+12)	129	25.9	100
Total	499	100.0	
Experience			
≤5 years	99	19.8	19.8
6-10 years	138	27.7	47.5
11-15 years	114	22.8	70.3
<15 years	148	29.7	100
Total	499	100.0	
ICT			
Having knowledge & experience	310	62.1	62.1
Having no knowledge & experience	189	37.9	100
Total	499	100.0	
Specialization			
Science	244	48.9	48.9
Mathematics	255	51.1	100
Total	499	100.0	

Note. P: Percentage & CP: Cumulative percentage

more than 15 years of experience representing 29.7%. The study also paid attention to the field of teacher's specialization, as the percentage of whose specializations are scientific (biology, chemistry, geology, and physics) is 48.9%, while the percentage of mathematics teachers is 51.1. Since the study is interested in e-learning and DE, the study sample was classified in terms of their possession of ICT knowledge and skills. The number of male and female teachers with technological knowledge and skills reached 310 out of 499 or 62.1%, while the number of male and female teachers without technological knowledge and skills reached 189 or 37.9%.

### Study Instruments

The researchers sand the theoretical literature and previous global, regional, and local studies related to the employment of various technologies in the educational learning process, such as electronic learning and teaching and DE. Then, they adopted and developed the study tool by using the questionnaire contained in the study of Al-Shorman and Bawaneh (2018) and Malkawi et al. (2020). The tools were translated from English into Arabic and the items were reformulated to comply with the objectives of the current study; some paragraphs

were added, deleted, and written according to the six-point Likert scale instead of the five-pointed Likert scale to avoid respondents resorting to the medium (neutral) option as well as increasing the accuracy and credibility of the results. In its initial form, the tool contained 32 items divided into three areas: Appreciating the importance of DE from the teachers' point of view (nine items), teachers' attitudes towards DE (11 items), and the challenges that teachers faced with DE during the COVID-19 pandemic (seven items).

### Validity

The researchers translated the study tools that were adopted from Malkawi et al. (2020) and the study of Al-Shorman and Bawaneh (2018) from English to Arabic and built a new tool that achieves the objectives of the current study. Then, Arabic and English versions were presented to a certified translator and experts who approved on the translated version in its final form according to the six-point Likert scale (strongly agree: 6; agree: 5; somewhat agree: 4; somewhat disagree: 3; disagree: 2; and strongly disagree: 1) for items formulated in a positive way, and the complete opposite for items formulated in a negative way—this was taken into account when analyzing the results by the SPSS program. To ensure the validity of the study tool, the preliminary version, which consisted of 32 items, was presented to eight experts, three of them are faculty members at Yarmouk University–Jordan, the University of Jordan, and Queen Rania Academy for Teacher Training, two educational supervisors who specialize in ICT, and three teachers (two female teachers: one in physics, the other in mathematics), and a male teacher specializing in chemistry. Some items have been deleted and the wording of several items has been amended in light of the agreement of more than 50.0% of the experts on the same paragraph (Al Salman et al., 2021; Bawaneh, 2021). The number of paragraphs of the questionnaire in its final form is 27 paragraphs.

### Reliability of the tool

To calculate the stability of the study tool, the researchers followed Cronbach's alpha test; the overall stability coefficient of the tool was 0.91, and the stability coefficients for the three domains of the tool were: The importance of DE from the teachers' point of view (0.89), teachers' attitudes towards DE (0.91), and the challenges that teachers faced in DE during the COVID-19 pandemic (0.87). These values of reliability are appropriate for data collection purposes in the humanities and social sciences (Al-Kellani & Al-Shraifeen, 2011; Obiedat et al., 2016).

### Statistical Standard for Classification of Items

Items of the questionnaire are classified into three categories denoting weak (W), medium (M), and high

(H) according to the numerical value of the mean ( $m$ ) of the individual items. For item classification, we adopt Eq. (1) (Al-Rashidi, 2018; Bawaneh et al., 2020) to obtain the paragraph class width  $P$ :

$$P = (U - L)/n, \quad (1)$$

where  $U$  and  $L$  represent the upper and lower limits of the scale, respectively, and  $n$  represents the number of required categories. To obtain the numerical value of  $P$  we substitute for  $U$ ,  $L$ , and  $n$  in Eq. (1), which yields:  $P=(6-1)/3=1.67$ .

Using the numerical value of  $P$ , namely 1.67, the three category intervals are determined along the range between 1.00 and 6.00. They were found to take the following values:  $W \in (1.00; 2.67)$ ,  $M \in (2.68; 4.35)$ , and  $H \in (4.36; 6.00)$ , representing weak, medium, and strong, respectively. As an example, a paragraph who's  $m$  lies within the range of 4.36 to 6.00, i.e., satisfies the inequality ( $4.36 < m < 6.00$ ) is categorized as  $S$ , denoting strong.

## RESULTS

To answer the study's first question, which is "to what extent do science and mathematics Jordanian teachers appreciate the importance of DE from their point of view?", the researchers calculated the means and standard deviations of the participants' scores in each of the nine items of this dimension of the tool, noting that the number of respondents was 499 male and female teachers. The results are shown in **Table 2**.

The results in **Table 2** show that the overall mean of the items related to the first dimension of the study, which is related to the degree of appreciation science and mathematics Jordanian teachers have for the importance of DE from their point of view is 3.55. This indicates that their proficiency level of DE is in the middle category, while the highest mean for the first item in this dimension is 4.06, which indicates that teachers' appreciation of the importance of knowing DE skills is necessary for all schoolteachers because of its role in developing research and investigation skills, which was confirmed by the third item (3.90). It is worth mentioning here the high maturity of science and mathematics Jordanian teachers in taking advantage of various websites and platforms in order to enrich the lessons they provide to students, as well as their activation of many technological tools and applications that enhance student learning of science and mathematics in light of the COVID-19 pandemic as stated in item 8 and item 9. While we find dissatisfaction with teachers who think this style of teaching and learning reduces communication between students and teachers and between students themselves, the teacher also determines his ability to consider diversity among students according to item 6 and item 7 that came in the last order.



**Table 2.** Means, standard deviations, & items categories of first dimension: Importance of distance education from science & mathematics teachers' point of view

No	Item	M	SD	IC
1	Knowledge of DE skills is essential for all schoolteachers.	4.06	1.17	MD
2	DE gives me many options in presenting and displaying textbook content.	3.56	1.42	MD
3	DE develops my research and investigation skills.	3.90	1.43	MD
4	Use of DE helped me develop twenty-first century skills of my students such as (creative thinking, collaborative learning, & problem solving).	3.52	1.38	MD
5	DE increases social interaction between me and my students.	3.31	1.43	MD
6	DE contributes to increasing interaction & sharing ideas among students.	3.13	1.42	MD
7	DE considered diversity among learners (individual differences, thinking styles, motivation, etc.).	3.18	1.29	MD
8	I was able to activate many of ready-made tools & programs in teaching my students content via DE that I was not able to use in regular classes.	3.63	1.35	MD
9	I benefited from pre-prepared lessons on the Internet & various educational platforms, & I focused with my students on reflection & feedback about learning they got from watching these lessons.	3.69	1.21	MD
Overall		3.55		MD

Note. M: Mean; SD: Standard deviation; IC: Item category; MD: Medium; & DE: Distance education

To answer the second question, which states “does science and mathematics Jordanian teachers’ degree of appreciation differ with the difference of some variables (gender, region, stage of taught, experience, possession of ICT, and the teacher’s specialization)?” The researchers calculated the means and standard deviations related to the teacher’s gender, the region in which he works, the stage he teaches, the number of years of experience, his possession of information technology knowledge and skills, and finally his field of specialization; the results came as in **Table 3**.

**Table 3** indicates the means and standard deviations for the degree of appreciation science and mathematics Jordanian teachers have for the importance of DE from their point of view according to some variables. We find a difference in the mean between males and females by 0.16 in favor of males, where the mean for males was 3.68 with a standard deviation of 0.912, and the mean for females was 3.52 with a standard deviation of 0.934. The highest mean for the degree of appreciation science and mathematics Jordanian teachers have for the importance of DE in the North was 3.61, then follows the Middle territories with mean 3.52; finally, the South by 3.49. As for the means of the teacher’s degree of appreciation to the importance of DE according to the stage they teach, the highest average came for the secondary stage, then the low basic stage, and finally the high basic stage (3.62, 3.55, and 3.50), respectively. The means of the teacher’s degree of appreciation to the importance of DE according to the years of experience varies as the lowest average for the category of teachers with 10-15 years was 3.43, while the highest average was 3.68 for teachers with the most experience within the category (more than 15 years). At the same time, the means for the two categories (less than five years, five-10 years) were convergent in the order (3.56, 3.51). Since the study is related to the employment of technology in teaching and learning, it focused on the variable of teachers’ possession of technical knowledge and skills, and the mean for those with technical skills was the highest

**Table 3.** Means & standard deviations of degree of Jordanian science & mathematics teachers’ awareness of importance of distance education from their point of view due to some variables

Variables	n	M	SD
Gender			
Male	118	3.68	.912
Female	381	3.52	.934
Total	499	3.55	.931
Region			
North	211	3.61	.898
Middle	199	3.52	.923
South	089	3.49	1.02
Total	499	3.55	.931
Stage			
Low basic (4-7)	227	3.55	.902
High basic (8-10)	143	3.50	.970
High school (11+12)	129	3.62	.940
Total	499	3.55	.931
Experience			
≤5 years	99	3.56	.883
6-10 years	138	3.51	.936
11-15 years	114	3.43	.983
<15 years	148	3.68	.908
Total	499	3.55	.931
ICT			
Having knowledge & experience	310	3.65	.926
Having no knowledge & experience	189	3.41	.922
Total	499	3.55	.931
Specialization			
Science	244	3.56	.919
Mathematics	255	3.55	.943
Total	499	3.55	.931

Note. M: Mean & SD: Standard deviation

(3.65), while the teachers’ average of those who do not possess the least knowledge and technical skills was 3.41. Finally, the difference between the means of the teachers’ appreciation of the importance of DE according to the field of specialization: science and mathematics was 0.01. By reading the above results, we find that there

are apparent differences of varying size in the means of the degree of appreciation science and mathematics Jordanian teachers have for the importance of DE for all variables of study: gender, region, stage taught by the teacher, number of years of experience, possession of information technology knowledge and skills, and the teacher's field of specialization. To ensure the significance of the differences, the researchers carried out one-way ANOVA and the results are shown in **Table 4**.

It appears from **Table 4** that the value of statistical significance at  $\alpha=0.05$  for the degree of appreciation science and mathematics Jordanian teachers have for the importance of DE from their point of view for all study variables: gender, region, the stage taught by the teacher, the number of years of experience, and the teacher's field of specialization is greater than 0.05, and this means that there are no statistically significant differences for all variables except for the teacher's possession of information technology knowledge and skills, where the value of statistical significance was 0.014,  $F=4.271$ , that is, there is a difference in the degree of appreciation science and mathematics Jordanian teachers have for the importance of DE from their point of view and in favor of a group of teachers who possess information technology knowledge and skills.

To answer the third study question, which states "what is science and mathematics Jordanian teachers' attitudes level towards DE?" The researchers calculated the means and standard deviations for the 11 paragraphs of this dimension of the tool, the number of respondents was 499 male and female teachers. The results are shown in **Table 5**.

The results in **Table 5** show that the overall mean of the items related to the second dimension of the study, which aimed to explore science and mathematics Jordanian teachers' attitudes from DE came 3.95. This means their attitudes towards DE are within the intermediate category. Science and mathematics

**Table 4.** One-way ANOVA for degree of appreciation science & mathematics Jordanian teachers has for importance of distance education from their point of view

Variables	SS	df	MS	F	Sig.
<b>Gender</b>					
Between groups	2,357	1	2,357	2,727	.099
Within groups	429,565	497	.864		
Total	431,922	498			
<b>Region</b>					
Between groups	1,240	2	.620	.714	.490
Within groups	430,682	496	.868		
Total	431,922	498			
<b>Stage</b>					
Between groups	.851	2	.426	.490	.613
Within groups	431,071	496	.869		
Total	431,922	498			
<b>Experience</b>					
Between groups	4,557	3	1,519	1,760	.154
Within groups	427,365	495	.863		
Total	431,922	498			
<b>ICT</b>					
Between groups	7,312	2	3,656	4,271	.014*
Within groups	424,611	496	.856		
Total	431,922	498			
<b>Specialization</b>					
Between groups	.724	2	.362	.416	.660
Within groups	431,199	496	.869		
Total	431,922	498			

Note. SS: Sum of squares & MS: Mean squares

teachers have some reservations towards DE, and this is evidenced by the fact that the highest items in the mean in this dimension is the eighth item, with a mean of 4.52, which indicate teachers' lack of confidence in DE because it reduces their privacy and intellectual property. Likewise, the tenth item with a mean of 4.50 indicates teachers need and desire to attend specialized training programs in the mechanisms of employing digital platforms and technological tools in teaching and learning. Then came the seventh item with an average of 4.25, which shows teachers' concerns about poor

**Table 5.** Means, standard deviations, & items categories of second dimension: Science & mathematics teachers' attitudes towards distance education

No	Item	M	SD	IC
1	I love teaching through using computers and the Internet.	4.11	1.34	MD
2	Teaching lessons through distance learning saves me time and effort.	3.24	1.48	MD
3	Use of DE is an appropriate solution in exceptional circumstances-Spread of epidemics and wars.	4.13	1.21	MD
4	I would like to use distance education in normal circumstances.	3.19	1.46	MD
5	I believe that education by regular teaching methods gives better results than DE.	4.06	1.20	MD
6	DE limits my freedom of thought.	3.99	1.44	MD
7	DE weakens the social bond between me and my fellow teachers.	4.25	1.32	MD
8	I do not trust DE in terms of privacy and intellectual property.	4.52	1.38	H
9	I am convinced of the usefulness of DE.	3.40	1.33	MD
10	I like to enroll in specialized training programs that help me use DE systems & tools efficiently.	4.50	1.32	H
11	Difference in tools & programs that I use & that of my colleagues from same major & other majors may confuse students.	4.06	1.08	MD
<b>Overall</b>		3.95		MD

Note. M: Mean; SD: Standard deviation; IC: Item category; MD: Medium; H: High; & DE: Distance education

relationships and social communication between teachers due to school closures and reliance on DE. We also find that the fourth item is the lowest in the mean 3.19 within this dimension, which indicates the unwillingness of science and mathematics teachers in the continuity of DE after the end of the COVID-19 pandemic (in normal circumstances). In other words, the teachers do not want to continue employing DE after the pandemic. Moreover, in the second item, with a mean of 3.24, teachers confirm that DE requires more time and effort to present their lessons to students effectively.

To answer the fourth question, which is “does science and mathematics Jordanian teachers’ level of attitudes differ with the difference of some variables (gender, region, stage of taught, experience, possession of ICT, and the teacher’s specialization)?” The researchers calculated the means and standard deviations associated with the study variables. The results are shown in **Table 6**.

**Table 6** indicates the means and standard deviations of the attitudes science and mathematics Jordanian teachers have towards DE. We find the difference in the mean between males and females (0.09) in favor of males, where the mean for males was 4.02 with a standard deviation of 0.498, and the mean for females was 3.93 with a standard deviation of 0.510. The means of teachers’ attitudes towards distance learning in the three regions were close (North: 3.95, Middle: 3.93, South: 3.99); all of which were within the middle category. As for the mean of the teachers’ attitudes towards DE according to the stage they taught, the higher average for the secondary stage was 3.98 in the middle category, while the mean for the low basic and high basic stages came close (3.94, 3.93), respectively. The means of the teachers’ attitudes to distance learning according to the number of years of experience were also remarkably close, with a difference of no more than 0.02; noting that the higher average was for the less experienced and most experienced categories according to the classification of the study, while the lower means were for the two categories with intermediate experience. Since the study is related to the employment of technology in teaching and learning, it was concerned with the variable of teachers’ possession of technical knowledge and skills, and the mean for those with technical skills was the highest (4.01), while the attitudes’ mean of came for the category of those who do not possess the least knowledge and technical skills (3.87). Finally, there was a difference between the means of the Jordanian teachers’ ability degree to teach remotely according to the field of specialization (science and mathematics) little (0.02). By reading the above results, we find that there are apparent differences of varying size in the mean of the teachers’ attitudes towards DE for all the study variables: gender, region, the stage taught by the teacher, number of years of experience, possession of information technology knowledge and skills, and the

**Table 6.** Means & standard deviations of attitudes science & mathematics Jordanian teachers have towards distance education

Variables	n	M	SD
<b>Gender</b>			
Male	118	4.02	.498
Female	381	3.93	.510
Total	499	3.95	.508
<b>Region</b>			
North	211	3.95	.460
Middle	199	3.93	.515
South	89	3.99	.596
Total	499	3.95	.460
<b>Stage</b>			
Low basic (4-7)	227	3.94	.520
High basic (8-10)	143	3.93	.530
High school (11+12)	129	3.98	.462
Total	499	3.95	.508
<b>Experience</b>			
≤5 years	99	3.96	.543
6-10 years	138	3.94	.533
11-15 years	114	3.94	.515
<15 years	148	3.96	.457
Total	499	3.95	.508
<b>ICT</b>			
Having knowledge & experience	310	4.01	.496
Having no knowledge & experience	189	3.87	.507
Total	499	3.95	.508
<b>Specialization</b>			
Science	244	3.96	.477
Mathematics	255	3.94	.530
Total	499	3.95	.508

Note. M: Mean & SD: Standard deviation

teacher’s field of specialization. To ensure the significance of the differences, the researchers conducted a one-way ANOVA results are shown in **Table 7**.

**Table 7** shows that there are statistically significant differences in the attitudes of Jordanian teachers towards DE due to two variables of the study, the teacher’s possession of information technology knowledge and skills, where the value of statistical significance was 0.001,  $F=7.652$ , which means there is a difference in attitudes towards DE in favor of the group of teachers who possess information technology knowledge and skills. There are also statistically significant differences for the variable of the teacher’s field of specialization in favor of the science teachers, where the value of statistical significance was 0.047,  $F=3.080$ . We also notice that the results did not show statistically significant differences for the rest of the independent variables of the study (gender, region, stage taught by the teacher, number of years of experience) in relation to teachers’ attitudes towards DE.

To answer the fifth study question, which is “what level of challenges did the science and mathematics Jordanian teachers face in DE?” The researchers calculated the means and standard deviations for the

**Table 7.** One-way ANOVA for science & mathematics Jordanian teachers' attitudes towards distance education

Variables	SS	df	MS	F	Sig.
<b>Gender</b>					
Between groups	.704	1	.704	2,731	.099
Within groups	128,079	497	.258		
Total	128,783	498			
<b>Region</b>					
Between groups	.231	2	.116	.446	.640
Within groups	128,552	496	.259		
Total	128,783	498			
<b>Stage</b>					
Between groups	.184	2	.092	.354	.702
Within groups	128,599	496	.259		
Total	128,783	498			
<b>Experience</b>					
Between groups	.041	3	.014	.053	.984
Within groups	128,742	495	.260		
Total	128,783	498			
<b>ICT</b>					
Between groups	3,854	2	1,927	7,652	.001*
Within groups	124,929	496	.252		
Total	128,783	498			
<b>Specialization</b>					
Between groups	1,580	2	.790	3,080	.047*
Within groups	127,203	496	.256		
Total	128,783	498			

Note. SS: Sum of squares & MS: Mean squares

seven items of this dimension of the tool. The number of respondents was 499 male and female teachers. The results are as shown in **Table 8**.

The results show in **Table 8** that the overall mean of the items related to the third dimension of the study, which aimed to know the most important challenges that faced science and mathematics Jordanian teachers in DE came under the high category reached 4.38. This means that there are many challenges that Jordanian teachers faced during DE. Through the results shown in **Table 8**, we find that the most important of these problems or challenges is the difficulty of finding an appropriate and

credible way to evaluate students' performance in DE according to the fifth item, which has a mean of 4.88. Teachers also indicated the difficulty of communicating with students due to poor infrastructure and lack of means of communication. Among the problems that teachers faced during distance teaching was the inability of many students to employ and use distance learning platforms, as in the seventh item, where the mean (4.72) came under the high category. This problem was not limited to students, as the third item directly indicates the need of many teachers for programs specialized in information technology mechanisms and how to teach remotely through the platforms designed for that; in addition to the lack of many students and teachers of modern smart devices necessary for e-learning. On the other hand, the results showed the teachers' need to be trained on many topics related to teaching science and mathematics remotely such as designing content, various activities associated with educational technology theories, virtual classroom management, and other issues.

**To answer the sixth question**, the last one in this study, which is "does the level of challenges science and mathematics Jordanian teachers faced differ according to the difference of some variables (gender, region, stage of taught, experience, possession of ICT, and the teacher's specialization)?" The researchers calculated the means and standard deviations associated to the study variables; the results are as shown in **Table 9**.

**Table 9** indicates the means and standard deviations for the level of challenges science and mathematics Jordanian teachers faced in DE according to some variables. Where we find differences in the mean between males and females by 0.07 in favor of females; the mean for males was 4.32 with a standard deviation of 0.525, and the mean for females was 4.39 with a standard deviation of 0.520. We find that the challenges in the Southern region were the most with a mean of 4.43 and a standard deviation of 0.539, then in the Northern region, followed by the Central region with means 4.38

**Table 8.** Means, standard deviations, & items categories of third dimension: Challenges science & mathematics Jordanian teachers faced in distance education

No	Item	M	SD	IC
1	Use of DE posed a challenge to me in designing educational activities & tasks in an interactive way with my students.	3.90	1.17	MD
2	I am concerned about how much some parents of my students can support me in educating their children through DE.	3.81	1.02	MD
3	I had difficulty dealing with most applications that support DE due to use of my mobile device & lack of a computer.	4.61	1.39	H
4	I am having difficulty finding right time to teach & follow up on my students & children at same time in DE.	3.84	1.06	MD
5	I find it difficult to find an appropriate & reliable way to assess my DE students.	4.88	1.20	H
6	I am finding it difficult to reach all my students whom I teach in DE due to lack of means of communication with them.	4.86	1.28	H
7	I find it difficult to train students to use tools & programs that I use in DE.	4.72	1.21	H
Overall			4.38	H

Note. M: Mean; SD: Standard deviation; IC: Item category; MD: Medium; H: High; & DE: Distance education

**Table 9.** Means & standard deviations for level of challenges science & mathematics Jordanian teachers faced in distance education

Variables	n	M	SD
Gender			
Male	118	4.32	.525
Female	381	4.39	.520
Total	499	4.37	.522
Region			
North	211	4.38	.506
Middle	199	4.34	.530
South	89	4.43	.539
Total	499	4.37	.522
Stage			
Low basic (4-7)	227	4.38	.541
High basic (8-10)	143	4.34	.508
High school (11+12)	129	4.41	.502
Total	499	4.37	.522
Experience			
≤5 years	99	4.37	.578
6-10 years	138	4.36	.522
11-15 years	114	4.37	.492
<15 years	148	4.39	.508
Total	499	4.37	.522
ICT			
Having knowledge & experience	310	4.35	.536
Having no knowledge & experience	189	4.41	.496
Total	499	4.37	.522
Specialization			
Science	244	4.36	.534
Mathematics	255	4.39	.510
Total	499	4.37	.522

Note. M: Mean & SD: Standard deviation

and 4.34, and standard deviations of 0.506 and 0.530, respectively. The means of the challenges faced by Jordanian teachers according to the number of years of experience were very close with a difference of no more than 0.02. Since the study is related to the employment of technology in teaching and learning, it was concerned with the variable of teachers' possession of technical knowledge and skills, and the mean of those with technical skills was the least (4.35), while the mean of the challenges faced by teachers in DE came the most from the category of those who do not possess technical knowledge and skills (4.41). This means that the suffering of teachers who have technological information was less during DE than those who do not have technological information and skills. Finally, the difference between the means of the challenges faced by Jordanian teachers in DE according to the field of specialization: Science and mathematics (0.03) in favor of mathematics teachers; this means that the challenges faced by the teachers of mathematics are more than those of the science teachers. By reading the above results, we find that there are apparent differences of varying size in the means of the challenges science and mathematics Jordanian teachers faced in DE for all the study variables: gender, region, the stage taught by the teacher, number

**Table 10.** One-way ANOVA of challenges science & mathematics Jordanian teachers faced in distance education

Variables	SS	df	MS	F	Sig.
Gender					
Between groups	.534	1	.534	1,964	.162
Within groups	135,188	497	.272		
Total	135,722	498			
Region					
Between groups	.540	2	.270	.991	.372
Within groups	135,182	496	.273		
Total	135,722	498			
Stage					
Between groups	.373	2	.187	.684	.505
Within groups	135,349	496	.273		
Total	135,722	498			
Experience					
Between groups	.059	3	.020	.072	.975
Within groups	135,663	495	.274		
Total	135,722	498			
ICT					
Between groups	.588	2	.294	1,079	.341
Within groups	135,134	496	.272		
Total	135,722	498			
Specialization					
Between groups	.301	2	.151	.552	.576
Within groups	135,421	496	.273		
Total	135,722	498			

Note. SS: Sum of squares & MS: Mean squares

of years of experience, possession of information technology knowledge and skills, and the teacher's field of specialization. To ensure the significance of the differences, the researchers carried out one-way ANOVA. The results were as shown in **Table 10**.

The results in **Table 10** indicate that there are no statistically significant differences at the significance level ( $\alpha=0.05$ ) in the challenges science and mathematics Jordanian teachers faced in DE and for all the independent variables of the study (gender, region, the stage taught by the teacher, number of years of experience, possession of information technology knowledge and skills, and the teacher's field of specialization). The statistical significance values for the variables were 0.162,  $F=1.964$ ; 0.372,  $F=0.991$ ; 0.505,  $F=0.684$ ; 0.975,  $F=0.072$ ; 0.341,  $F=1.079$ ; 0.576,  $F=0.552$ , respectively. This means that all teachers, males, and females, from all regions of the Kingdom, regardless of their experience, the stage they teach, their field of specialization, and their knowledge and technological skills, suffer at the same level from the challenges of DE.

## DISCUSSION

The appreciation level of science and mathematics Jordanian teachers to the importance of DE from their point of view came within the medium category, and this can be considered an indication of the awareness of teachers about the importance of having the necessary

knowledge and skills for DE. The researchers attribute this to the fact that teachers found a space of professional freedom in DE more than in face-to-face education represented in distributing their classes schedule throughout the week at times that suit them as well as correspond with their students. Even the students themselves found this style of education more satisfying to their needs and tendencies, which contributed to increasing their interaction with their teachers. This was supported by what the Ministry of Education has done in emphasizing the importance of the use of technology in teaching through its keenness to train teachers to have computer and technological skills represented in the launch of the international computer driving license program ICDL, Intel software and other programs that have been taken into consideration for the purposes of ranks, promotions, and the payment of a financial bonus, which increased the turnout of most teachers on these programs, reinforced their digital culture, and continuously motivated teachers to employ technology in education. On the other hand, the teachers' appreciation level to the importance of DE from their point of view within the medium category can be seen from another angle for not employing DE in an official and organized manner specific courses by the Ministry, as well as the poor ability of teachers to hire the mechanisms of technology in teaching and learning due to their lack of practice for long periods of time besides the convictions of some decision makers that it was not needed before the COVID-19 pandemic. This study showed that there are no statistically significant differences in the degree of teachers' appreciation to the importance of DE for all variables except for the variable of the teacher's possession of information technology knowledge and skills. We can attribute the variable of teachers' possession of technological knowledge and skills to the fact that those teachers found opportunities to demonstrate and employ their technological skills in real interactive contexts, and that DE environment is a fertile environment for developing their creative technological skills and increasing their motivation to invest this knowledge in teaching their students. Moreover, many of them joined additional training courses to integrate technology into education, which dealt with the mechanisms of using many programs, applications, tools and technological platforms that contributed to raising their appreciation for the importance of using technology and applying DE styles with their students. That made it easier for them to design and provide lessons compatible with DE environment and transfer what they learned in the training programs for their students to communicate with them effectively.

The results of this study also indicated that the level of science and mathematics Jordanian teachers' attitudes towards DE came with a moderate degree, and this result is consistent with the previous result in terms of

teachers' appreciation of the importance of DE. Many teachers have expressed their desire to join specialized training programs, which is evidence of their awareness of the changes taking place in their roles and responsibilities in DE environment, and that this type of education has become a necessity. On the contrary, we find that many teachers have concerns about the quality of teaching through DE. Furthermore, the insufficient knowledge of how to effectively communicate with students and colleagues in the distance learning environment generates some negative attitudes towards it. These attitudes appeared in the teachers' response to the seventh item of the questionnaire due to the closure of schools and their inability to communicate and exchange daily conversations with their fellow teachers in the school as is the case in normal days. Changing the daily routine may be difficult for some, especially if it is sudden and considering a pandemic like the COVID-19 pandemic in which everyone is in a state of psychological tension from it and its consequences. The study showed that there is a difference in the attitudes of teachers towards DE and in favor of teachers who possess information technology knowledge and skills; we can attribute this to their ability to deal flexibly with the designing and delivering the content for students remotely and their technological skills that enabled them to communicate with students and continue the educational process. The results of the study also showed a difference in teachers' attitudes according to their specializations and in favor of science teachers. The researchers attribute this result to the nature and specificity of mathematics, where it is somehow difficult for its teachers to turn it into interactive activities in addition to the lack of applications that serve to activate such activities, and the difficulty of using many tools and ready-made applications with students as is the case for applications related to scientific investigations, which often do not have to be in Arabic.

Besides, the results of this study indicated that the challenges science and mathematics Jordanian teachers faced during DE came under the high category. The most prominent of these challenges was the lack of a credible way to assess students through technological assessment tools. We may attribute this to the novelty of this type of evaluation for teachers, to the evaluation in schools being based on paper and pen in most tests, and to the belief of many teachers that remote evaluation may not be done by students on their own, which affects the credibility of their evaluation as it reflects their actual level; additionally, many teachers' lack of knowledge about using digital applications that support remote assessment methods and not undergoing adequate training on how to design them in a DE environment to present them to students. Moreover, the inability to reach all the students they teach is due to the lack of means of communication. The results of this study also showed that there were no statistically significant

differences regarding the challenges that teachers faced during DE for all study variables. We can attribute this to the fact that this experience came in sudden circumstances that affected all teachers of both genders in all parts of the Kingdom and for all disciplines and grades. Despite some teachers' possession of technological skills and knowledge, this knowledge might not be sufficient, or it might mean that they have undergone training in technical skills a long time ago, but they did not practice it in the classroom with their students. It might also be because of the need for teachers to possess the knowledge and skills to use specialized programs in DE of all kinds. Since the teachers in public schools do not possess the skills of designing educational units in a DE environment, the training they received may not be sufficient with regard to designing the content of the curriculum they teach, preparing appropriate assessment methods and tools, and how to deal and communicate effectively with students in DE environment; given the fact that they are accustomed to employing technological tools and applications with their students while they are in the same class (e-learning) and there was no need for them to use DE at the time.

Although the degree of interest science and mathematics Jordanian teachers and their attitudes towards DE was moderate, but we note the agreement of this result with the results of many studies (Al-Shunnaq & Doumi, 2010; Celen et al., 2013; Mailizar et al. al., 2020; Nasser & Abouchdid, 2000; Zhou et al., 2020) in that the degree of interest and attitudes of teachers towards DE is positive, and that they see it as an appropriate solution in exceptional circumstances such as wars and epidemics. On the other hand, we find many studies (Al-Hawamdeh, 2011; Mailizar et al., 2020; Raes et al., 2020; Senteme, 2020) agreed with the results of this study that there are many challenges in DE, where the challenges were centered around electronic platforms and the mechanism of their use, the Internet networks, the readiness of the infrastructure, tools and materials necessary for DE, the skills of using technology that enable teachers to effectively deal with DE, designing academic content in accordance with the principles and theories of DE, and designing assessment methods and tools compatible with learning outcomes and teaching methods.

### Study Recommendations

1. Designing and implementing training programs specialized for science and mathematics teachers on mechanisms for effectively employing DE platforms and how to use some electronic applications and educational media.
2. Redesigning the teaching content for science and mathematics courses according to the models and theories of DE and its mechanisms for effective presentation in addition to building methods for
3. Developing a schedule for distributing classes and distance teaching in a flexible manner that considers several variables (teachers and students time, number of students, teachers' schedule, number of courses and classes given weekly), in addition to focusing on asynchronous and recorded lessons that students can refer to at times that suit their circumstances and needs.
4. Providing internet services with free and sufficient packages for teachers and distributing personal computers or laptops for teachers.
5. Providing schools with adequate infrastructure, tools, and resources to enable them to fulfill the requirements of distance learning and education.
6. Conducting more studies related to DE and involving students, parents, and other stakeholders to develop, improve and upgrade DE as a suitable alternative in exceptional circumstances.

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**Data sharing statement:** Data supporting the findings and conclusions are available upon request from the corresponding author.

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