education sciences

MDPI

Article

A Comparative Study of the Effects of Distance Learning and Face-to-Face Learning during the COVID-19 Pandemic on Learning Mathematical Concepts in Primary Students of the Kingdom of Bahrain

Mansour Saleh Alabdulaziz * and Enas Anwar Tayfour

Department of Curriculum and Instruction, College of Education, Imam Abdulrahman Bin Faisal University, Dammam 31451, Saudi Arabia

* Correspondence: malabdulaziz@iau.edu.sa or m.alabdulaziz@hotmail.com

Abstract: The main objective of this study is to compare the effectiveness of face-to-face learning and distance learning in helping fourth-grade primary students learn mathematical concepts. The data were collected from 120 fourth-grade students selected purposively and divided into two groups: a control group comprising 60 students, who used a face-to-face programme in their third grade, and an experimental group comprising 60 students, who used a distance learning programme in their third grade. A diagnostic test was used to measure their understanding of previous mathematical concepts. The current research revealed two interesting results: First, there were no statistically significant differences (p-value < 0.05) in rounding and ordering numbers, space concept, perimeter concept, and graphs between the face-to-face mode and distance learning mode, where students' results were almost similar. Second, there were statistically significant differences (p-value < 0.05) in the concepts of expanding pictures of numbers (verbal, analytic, and standard), compare numbers, basic arithmetic operations, units of measurement, geometric shapes, sides, and data visualisation in favour of the group of students who were taught in a face-to-face learning mode.

Keywords: distance learning; face-to-face learning; mathematical concepts; COVID-19 pandemic; primary students; Kingdom of Bahrain

Citation: Alabdulaziz, M.S.; Tayfour, E.A. A Comparative Study of the Effects of Distance Learning and Face-to-Face Learning during the COVID-19 Pandemic on Learning Mathematical Concepts in Primary Students of the Kingdom of Bahrain. *Educ. Sci.* **2023**, *13*, 133. https://doi.org/10.3390/educsci13020133

Academic Editor: Randall S. Davies

Received: 25 November 2022
Revised: 23 January 2023
Accepted: 25 January 2023
Published: 28 January 2023

1. Introduction

The prevalence of COVID-19 has meant that most countries, including the Kingdom of Bahrain, have faced many challenges, particularly in the field of education, where systems were forced to change by switching from face-to-face learning modes to distance learning modes through online classes [1].

The government of the Kingdom of Bahrain was mindful of the different conditions facing students. Therefore, instead of closing educational institutions completely, the Ministry of Education offered students two choices: continue to learn in a face-to-face learning mode or learn through a distance learning mode [2].

As with any sudden change, reluctance and fear to choose were seen, especially among primary school students, because both modes have advantages and disadvantages and present certain challenges. On the one hand, distance learning enables students to contact their teachers and access their educational content easily [3,4]. Moreover, it helps students to reduce effort and time by being able to follow lessons from anywhere and at any time. On the other hand, face-to-face learning is often preferred as a more efficient approach, especially at the primary stage, because students need a mentor and teacher who is always focused on them and controls the outcomes that need to be reached.

Each learning mode has always generated intense debate over its effects between opponents and supporters. Researchers and those interested in the educational field

have therefore conducted investigations to determine the effectiveness of each mode. For instance, a field experiment [5] compared the face-to-face learning mode with technology-assisted learning to determine students' satisfaction with, and the effectiveness of, each learning mode. The results indicated that technology-assisted learning enhances students' acquisition of the kind of knowledge that requires abstract conceptualisation and reflective observation, but adversely affects students' ability to acquire knowledge that requires concrete experience. Moreover, the results suggested that technology-assisted learning is better than face-to-face learning in terms of gaining vocabulary.

Another study [6] aimed to determine whether students undertaking distance learning and face-to-face learning were equally accepting and satisfied with the quality of their learning. The results indicated that both learning modes scored equally in terms of student satisfaction and the learning outcomes; however, each mode raised different challenges and required markedly different actions.

Finally, the authors of [7] sought to identify the success factors that differentiate face-to-face learning from distance learning mode. They found no significant differences between the two modes when success factors were determined. This suggests that students can learn just as effectively in either of the two formats, whatever their style of learning.

The studies reviewed therefore differed in their results; some showed the advantages of one learning mode over the other, while others found no difference between the two modes. The inconclusive nature of these findings prompted us to investigate and fill this research gap by learning more about the effectiveness of the two learning modes.

1.1. The Research Problem

We identified the problems as follows:

First, when the Minister of Education announced that distance learning would be used even after the end of the pandemic, because it saves expenditure on financial and human resources without affecting the services provided to students [8], educators, including the authors of this study, wondered if there were differences in acquiring concepts between the two modes (face-to-face learning and distance learning). We must not forget that [9] found that 83% of teachers admitted that it was difficult to explain complex scientific concepts.

Second, the Kingdom of Bahrain considers mathematics to be one of the subjects that deserves much attention in order to meet the needs of Bahraini society and the vision of the Kingdom of Bahrain by 2030. It prepares citizens who are able to contribute to the development of the Kingdom and the development of its economy by providing them with mathematical skills and knowledge [10]. Therefore, we consider it to be essential to reveal the effectiveness of learning modes in understanding mathematical concepts.

Third, although many case studies, experimental studies, guidelines, and comparative studies have been published on distance learning and face-to-face learning, there is still a need to investigate the effect of each mode in depth, especially in the Kingdom of Bahrain, as well as to follow up recommendations made in previous studies, such as [11].

Fourth, the author of [12] asserted that it is unhelpful to determine only the differences between face-to-face and online modes without mentioning the effectiveness of each. Moreover, we note that previous research has been divided into two groups: one in favour of distance learning and the other in favour of face-to-face learning, prompting us to further investigate the effectiveness of the two learning modes.

Fifth, we conducted an exploratory study by interviewing 20 primary teachers about the effects of distance learning and face-to-face learning during the pandemic. The results indicated that 70% of teachers thought that there was a knowledge gap between each learning mode. Furthermore, 60% of teachers thought that face-to-face learning was more effective in helping primary students acquire mathematics concepts, while 40% of teachers thought that distance learning was more effective. However, all teachers believed that it was important to carry out research to determine the effectiveness of each learning mode.

1.2. The Research Objective

The main objective of this study was not to prove which learning mode is better, but to compare the effectiveness of each in helping fourth-grade primary students acquire mathematical concepts that were included in their third-grade mathematics textbook.

2. Theoretical Framework

2.1. Distance Learning Mode

The distance learning mode, involving all school grades, was introduced in the 1990s [13]. In this method of study, teachers were able to instruct students in classrooms, without being physically present, using the internet [14].

Since then, researchers and theorists have been articulating distance learning theories. For example, [15] argues that early distance learning modes were more dependent on matters that border on teaching rather than learning. Progressively, the popularity and ease of distance learning has been greatly enhanced through integrating technologies into the educational process.

Recent theories have been more focused on changes that influence the learning of the students and the roles of the teachers. The authors of [16] reviewed four such theories, the first of which is set out in [17]. This theory focused on how to make students more independent by using technology and aiming to release teachers and students from the need to be in the same physical space for the educational process to be conveyed. In this sense, students are free to choose their learning formats and combine media and other methods for subjects to be taught in the best possible way. Employing media allows students to adapt materials to their individual learning needs and allow truthful evaluation of the students' achievements.

The second reviewed theory [18] is similar to [17]. It examines the effect of technological changes on distance learning. This theory posits that technology will redefine the roles of learners and teachers to make learning more autonomous and independent. The teacher's role will become more like a facilitator or guide which supports students.

The third reviewed theory of distance learning [19] expands on the theory of [18] in the changing roles of teachers and students, emphasising that the change of roles will promote and motivate interested students. They will interact more with content and have more desire to access information.

Finally, the fourth theory reviewed in [16] is [20], which acts as a combination of the ideas of [17–19]. This theory emphasises that for distance learning to be effective, multimedia programmes, regular activities, feedback, and a carefully organised system of teaching is necessary.

These theories depict how distance learning differs from face-to-face learning, particularly with the focus on student autonomy, technological impact, and the changes that accrue in the roles of the teacher.

It is very important to note that these theories can aid mathematics teachers to conceptualise courses, especially when they are planning for educational objectives. Additionally, if the goal of every educational programme and teacher is to ensure and encourage student learning, interactivity with the content, and with each other as students, then distance learning theories should also take into account that their capacity to assist mathematics teachers in course design and developing interactive activities is also essential.

Additionally, it is important to note that most of the learning process is underpinned by the principles of constructivism learning theory. It is significant that the theory of constructivism is well suited to distance learning due to its delivery process emphasising learner-centredness. Research has shown that constructivism learning theory focused on knowledge construction is based on students' previous experience, and can be drawn on to understand how learning occurs among students [21,22].

Furthermore, according to [23], one of the critical concepts of constructivist learning is that students can actively construct their own knowledge, where the student's mind uses information from the outside world to determine what the student will learn.

2.1.1. Technologies Used in Distance Education Delivery

The types of technologies used in distance learning are divided into two: synchronous and asynchronous. The former is a mode of online teaching and learning processes where all participants are present at the same time, requiring a timetable to be organised, while the latter is a mode of online teaching and learning processes where participants access course materials according to their own schedule, and they are not together at the same time. With regard to distance learning modes, the choice of delivery mode (synchronous or asynchronous) is a very critical issue, especially when considering contexts.

According to [24], there are four factors that determine students' preferences regarding tutorial modes: "time management", "ease of access" to learning materials, "positive aspects of interaction", and "negative aspects of interaction". Moreover, they found that those who prefer satellite-based synchronous tutorials have stronger views about the positive aspects of interactions and score lower on the need for autonomy and access to learning materials than those who prefer satellite-based asynchronous tutorials.

2.1.2. The Positive and Negative Aspects of Distance Learning

The positive and negative aspects of distance learning can be summarised as follows:

On the positive side, the distance learning mode provides flexibility in terms of access, as students can contact their teachers and access their educational content easily [3,4]. Moreover, distance learning supports the constructivist theory of instructional design in that students learn independently, which facilitates their construction of knowledge. Furthermore, distance learning enhances oral and written communication among students and their teachers [25].

On the negative side, it is difficult to apply tasks that require practical skills, as distance learning is limited to the theoretical cognitive aspects. Furthermore, most teachers rely on evaluating their students using closed-ended objective questions in quizzes and move away from open questions [3,4]. Some teachers and students also suffer from a lack of digital skills, which limits their performance during distance learning, and some face a permanent problem of communication on the Internet, which creates unequal opportunities for learning. In addition, problems may arise in providing electronic resources, such as videos and interactive educational applications, as these are emerging resources in some developing countries [26–28]. Finally, according to [29], a student's level of maturity plays an important role in their success when using distance learning, indicating that students who lack maturity will perform poorly. Due to the general lack of maturity of the primary-stage students compared to the other, older stages, primary students could be considered dependent learners in distance learning, forming a major obstacle to this mode [30].

According to [31], the characteristics of successful distance learners are self-motivation, emotional independence, and being capable of coping with learning problems on their own in order to conquer the barrier of physical separation. If primary-stage students can be self-directed, able to take control and responsibility of their learning, and manage their learning time, then they should be successful in the distance learning mode.

2.2. Face-to-Face Learning Mode

The face-to-face learning mode is one of the oldest educational modes and has been used since long before the advent of technology. Additionally, it is considered to be the key remaining time-tested and long-venerated teaching method, and the most frequently used method of instruction in education throughout the world ([32,33] p. 25, as cited in [34]).

Face-to-face learning is an effective approach because it can be predicted, managed, and controlled easily by mathematics teachers. Face-to-face learning is a more traditional style of learning in which knowledge is sent from the teacher to the students in a direct way [35], where students are physically present in the classroom and the teacher uses a chalk/white board, projector, etc. to discuss a topic. This learning mode is viewed as teacher-centered because the teacher conveys and promotes learning [36]. This leads us to wonder how students could benefit from the learning process in full. Students need to

be provided with the necessary environment that makes them active in developing their knowledge [37]. Ref. [38] strongly advocates for active learning as a crucial element of the new force to what is currently referred as learner-centred teaching involving students' performance and thought during tasks [39]. So, to make students active participants in face-to-face learning mode, there is a need for teachers to involve students in the teaching and learning process, so they can develop their own knowledge without the teacher's interference.

The Positive and Negative Aspects of Face-to-Face Learning

The face-to-face learning mode also includes positive and negative aspects, which can be summarised as follows:

On the positive side, face-to-face learning provides direct and synchronous communication and facilitates discussion and dialogue between the students and their teacher. Moreover, it provides an equal learning opportunity for all students, as it does not require the use of digital tools and technology for communication, and provides printed publications, educational content, and teaching aids that help students learn [40].

On the negative side, face-to-face learning may result in the learner adopting a passive role. It may also neglect the activities that take place outside the classroom, which limits creativity and innovation [40]. The face-to-face learning theory of 'sage on the stage' emphasises that the teacher is the centre of the learning process. This approach places the sole duty of learning on the teacher, and the transfer of knowledge from the teacher to the student. Thus, the teacher teaches as the students sit and take notes.

2.3. Similarities between Distance Learning and Face-to-Face Learning

With regard to the comparison of the efficacy of face-to-face and distance learning [41], revealed that distance learning can be used to provide innovative educational opportunities to fit the particular needs of students who have time management problems in their learning strategies, with low anxiety and high problem-solving efficacy. The authors of [42] evaluated the pedagogical characteristics of the two modes and revealed that students rated online lessons as far superior to face to-face lessons in terms of convenience and in permitting self-pacing, but they also rated online lessons as inferior in a number of other ways. Online and face to-face instructional modes, therefore, have their own strengths and weaknesses. However, distance learning and face-to-face are modes of education that both require students and a teacher. Moreover, both utilise organised educational content and arranged chapters, and both modes assess students through a class project and exams during and at the end of each semester. In addition, face-to-face and distance learning both depend on discussion, dialogue, and visual demonstrations [43].

3. Literature Review

3.1. First Axis: Research Comparing Distance Learning and Face-to-Face Learning

A study by [11] sought to identify ways in which both face-to-face learning and distance learning could be enhanced from a pedagogical perspective. The research focused on four dimensions of a training programme: 'theoretical content', 'practical content', 'tutor/student interaction', and 'design'. The participants comprised 250 students divided into two groups, one undertaking face-to-face learning (121) and one undertaking distance learning (129). Both quantitative and qualitative methods were employed to analyse the data. The results revealed no significant differences in the role of the teacher, but activities in the face-to-face learning mode were rated as less satisfactory and effective than those in the distance learning mode. However, the level of engagement between teachers and face-to-face students was greater and more productive than engagement between teachers and distance learning students. Additionally notable was the fact that the theoretical design and structure of the face-to-face programme was less effective than that of the e-training programme.

The authors of [44] compared the effectiveness of three courses delivered in a face-to-face format and in an offline format. Effectiveness was assessed in relation to instructional

features (learning content, course structure, lessons watched, communication, assignments, completion rate, grades, satisfaction, and engagement). For most of the variables, there were significant differences between online and face-to-face courses. For instance, face-to-face students reported better learning content. In contrast, online courses reported enhanced understanding of the course structure, more effective communication with course staff, and higher satisfaction and engagement. Their grades were also higher. However, there were no differences in completion rate.

The authors of [45] explored how academic performance in distance learning and face-to-face learning utilised by Al Ain University in Al Ain, United Arab Emirates to prevent COVID-19 was impacted by demographic characteristics. Data comprised grades and grade point averages (GPA) of students collected from the Admission and Registration Unit, Al Ain University in Al Ain, United Arab Emirates. The results indicated that students exhibited superior academic performance in distance learning. For instance, there were 11% fewer weaker students in distance learning than in face-to-face learning. Demographic characteristics significantly impacted the academic performance of students, predicting 7.4% of the variation in distance learning and face-to-face learning. The results are consistent with Tinto's (1975) model, which theorised the effect of students' experiences, attributes, and family backgrounds on academic performance. The researchers concluded that teachers should continue to offer distance learning alongside face-to-face learning programmes.

The authors of [46] compared levels of student achievement in 2019 and 2020 in a sample of matched primary schools in New South Wales as part of a study to assess the extent of disruption caused by COVID-19. The sample comprised 4800 Year 3 and 4 students. The data consisted of the results of progressive achievement tests in mathematics in both years. The results revealed no significant differences in levels of growth in student achievement between 2019 and 2020. Year 3 students in mid-ICSEA schools (950–1050) achieved an additional growth of 2 months in mathematics, while Year 3 students in the least advantaged schools (ICSEA < 950) exhibited a reduction in growth of 2 months. These findings provide a vital response to the general belief that the loss of learning for all students has been substantial. Nevertheless, to avoid any increase in inequality, the lower level of achievement in mathematics among Year 3 students in lower-ICSEA schools needs to be urgently addressed.

Additionally, the authors of [9] conducted a study to assess the effect of the COVID-19 lockdown in Nigeria on education and make recommendations to enhance the development of back-up strategies for remote teaching. The sample comprised 703 students and 60 teachers from five local universities who completed five-point Likert-scale questionnaires on their experiences, issues, and educational successes during the pandemic. The results indicated that a larger majority of participants (>50%) experienced problems with their Internet connection. Both students (67%) and teachers (59%) reported restricted teacher–student interactions, which negatively impacted satisfaction rates ($p < 0.01$). There was some divergence regarding the most effective method of assessment among students, while most teachers (63%) felt that assignments and oral examinations were more appropriate for online teaching. Most teachers (66%) found it difficult to assess the abilities and performance of their students. A sizeable number of students (>40%) expressed worries about the number of assignments they had to undertake. With respect to virtual assessments, the vast majority of teachers (84%) felt these increased the likelihood of misconduct in examinations. Compared to face-to-face teaching, students achieved significantly ($p < 0.05$) higher marks in all courses when these were assessed virtually. Finally, approximately 83% of teachers confessed that they found it hard to explain sophisticated scientific concepts.

3.2. Second Axis: Research on Mathematical Concepts

In [47], the authors aimed to determine the effect of using Posner's strategy in modifying the misperceptions of mathematical concepts among fourth-grade students. The study sample consisted of 84 female students from the fourth grade, who were categorized into two groups: one experimental and the other control, each group consisting of 42 students.

The study tools consisted of an analysis of math book and a diagnostic test. The researcher applied the post-diagnostic test again to the experimental and control group students. The results showed that there were statistically significant differences between the average scores of the experimental group students and the average scores of the control group students in the test for diagnosing wrong perceptions of mathematical concepts, favouring the experimental group.

A descriptive study [48] sought to identify the components of mathematical knowledge for teaching employed by prospective elementary teachers when planning, teaching, and reflecting on a mathematics lesson incorporating children's literature. Data were collected through observations and the written work of preservice elementary teacher candidates undertaking a course on methods of teaching mathematics. The analysis focused on knowledge of content and students, knowledge of content and teaching, and knowledge of content and curriculum. The results indicate that the ability of prospective teachers to identify and pinpoint mathematical concepts in children's literature needs to be enhanced. The authors also highlighted the need to assist prospective teachers in performing a critical analysis of mathematical concepts in children's literature and curricular materials.

Finally, the authors of [49] aimed to analyse the move to distance learning and the impact of this move on students' academic performance, taking into account several aspects, such as: synchronous/asynchronous delivery, the use of digital technologies, instruction, and class size. Additionally, the study compared the academic results of students during the COVID-19 pandemic with those of previous years. The sample consisted of students enrolled in 43 Bachelor's Degree courses. A quantitative method was used to collect data through a questionnaire. The results of this study showed that there were no significant differences between the different digital tools used in teaching the courses. Additionally, on one hand, the choice of learning mode did not affect students' academic performance, but on the other hand, students achieved better results under distance learning, which could be due to the knowledge, skills, and attitudes toward technology of higher education teachers. Additionally, the findings from this study suggest that class size, the choice of synchronous and asynchronous delivery, and the choice of virtual communication tools do not have a significant effect on students' academic performance.

3.3. Similarities and Differences between the Literature and This Research

First of all, in terms of participants, previous studies varied in how they selected their participants, and included samples from primary education, kindergarten, and higher education. For instance, refs [44,45] conducted research with university students, while [46,47] carried out research with participants at the primary stage, as is the case in the current study. Secondly, in terms of methodology, as in [44], the current study adopts a comparative approach. This contrasts with [46], who employed an experimental methodology. Thirdly, in terms of collecting data, the current study used a diagnostic test, in contrast to [46], who used progressive achievement tests, and [45], who collected data (GPA) from the Admission and Registration Unit. However, our data collection method is similar to [47], who applied the post-diagnostic test again to the experimental and control group students. Finally, the current study draws on previous studies in developing its theoretical framework and reviewing methods for statistically analysing the data.

3.4. The Research Questions

This study investigated the following research questions:

1. What are the mathematical concepts included in the diagnostic test for fourth-grade students?
2. How effective is the face-to-face learning mode in enabling fourth grade students to acquire mathematical concepts?
3. How effective is the distance learning mode in enabling fourth grade students to acquire mathematical concepts?
4. What is the difference between the effectiveness of both modes?

4. Methodology

To achieve the research objective, we applied a quantitative method using a comparative research design.

4.1. Participants

During the COVID-19 pandemic, the Ministry of Education in the Kingdom of Bahrain gave parents the freedom to choose the learning mode that was most appropriate for their children [2]. Therefore, the mode of learning was chosen based on the desire of the parents; according to this, we selected the participants and included them in the study.

In regard to ethical considerations, [50] suggests that researchers should understand that when they are conducting their research studies, they are entering their participants' personal spaces. Therefore, this requires ethical concerns to be addressed during and after the study. According to [51], the researcher has the responsibility of ensuring that participants' rights are taken into consideration. Based on this notion, we divided the most important ethical issues into four categories. Firstly, we obtained approval from the school administration to conduct the study, who assessed the ethical integrity of our research and then gave us approval and permission to proceed with this study (see Appendix A).

In addition, we obtained approval from the parents of the fourth-grade students at Primary Boys School, signed on their behalf by one of the parents who participated in the council of fathers (see Appendix B). Secondly, we informed the participants as fully as possible of the purpose of the research. Thirdly, we ensured that all participants signed the informed consent form without coercion before the study began, and we gave the participants a copy of the consent document. Fourthly, we ensured that each participant's identity alongside their personal information was kept confidential; thus, during the translation process, their names were not included. Finally, we made it clear to all participants that they were volunteers in this project and could withdraw any answers that they had provided, or withdraw their participation at any time without penalty.

The participants were purposively selected and consisted of 120 students from the fourth grade of the primary stage at Primary Boys School, who were divided into two groups:

A group comprising 60 students who used a face-to-face programme in their third grade;
A group comprising 60 students who used a distance learning programme in their third grade.

4.2. Participant Selection and Distribution Procedures

To ensure a fair comparison, we made the participants equivalent and homogeneous in terms of their characteristics. Thus, we verified the variables that could affect the validity of the comparison as follows:

Academic level: both groups were selected and distributed equally according to their academic level (GPA);
Social, cultural, and economic level: both groups belonged to a community characterised by convergence at cultural, economic, and social levels;
Content and number of activities: both groups were taught the same content and had taken the same activities in the previous semester;
Students' age (maturity): all participants were aged 10 years;
Synchronicity in learning: distance learning students learned using the Teams program in synchronous online classes, and face-to-face learning students learned through physically attending the school;
The assessment: both modes were assessed through the same exams, tasks, and class projects.

4.3. Overview of Details of the Conditions under which Distance Learning Took Place

First, the classroom environment: The lessons were presented through the Teams platform, using lessons that were synchronized with the students. This platform is characterized by the possibility of direct communication between the teacher and the student

by opening the camera and microphone or using chat. The Teams platform also made it possible for students to apply individual and group work during the lessons.

Second, teacher preparation:

1. The teacher presented lessons using PowerPoint on the Teams platform.
2. The teacher was trained to use the Teams platform and some of the electronic applications by the training department of the Ministry of Education.
3. The teacher used electronic activities and websites such as Wordwall and Live Worksheets.
4. The teacher used ClassDojo to encourage and motivate the students.
5. The teacher took into account the individual differences of the students and provided differentiated activities for them.

4.4. Overview of Details of the Conditions under Which Face-to-Face Learning Took Place

First, the classroom environment: Lessons were provided inside the classroom, and students were able to communicate directly with the teacher, taking into account social distancing. The students' activities were never permeated with group work, but were carried out individually to prevent any physical contact between students.

Second, teacher preparation:

1. The teacher presented a PowerPoint lesson on the classroom screen.
2. The teacher used paper activities.
3. The teacher used an individual scoreboard to encourage and motivate the students.
4. The teacher took into account the individual differences of the students and provided differentiated activities for them.

4.5. Variables

On one hand, the independent variable was the instructional learning mode. "Distance learning" was assigned to all sample groups that received learning instructions using the Teams program in synchronous online classes. Additionally, "Face-to-face learning" was assigned to all sample groups that received instruction using only a traditional face-to-face mode. On the other hand, the dependent variable was mathematical concepts, which was measured using data collected from the diagnostic test.

4.6. Instruments

There were two instruments used to achieve the research objective:

4.6.1. Content Analysis

The content analysis tool is a table where all the mathematical concepts within the selected book were identified and written into that table. The purpose of the analysis was to determine the most prominent mathematical concepts in a third-grade mathematics textbook so that these were included in the diagnostic test. The analysis sample was part 1 and part 2 of a third-grade mathematics book accredited by the Ministry of Education in the Kingdom of Bahrain for public schools. We measured the validity and reliability of the analysis by following scientific research procedures and reviewing previous theses in the following way: first, we determined the validity of the instrument by presenting the method of analysis and its results to five experienced mathematics teachers to elicit their opinions and views on its shortcomings. Second, we determined the reliability of the instrument using two reliability coefficients (agreement percentage): reliability over time (consistency over time) and reliability across individuals.

First, reliability over time (consistency over time). We analysed the content of both parts of the mathematics book at the beginning of September 2021. The analysis was then conducted again at the beginning of October (about a month after the first analysis). Table 1 summarises the results of the analysis on both occasions:

Table 1. Results of content analysis by researchers.

The Resulting Mathematical Concepts	First Analysis	Second Analysis	Agreement Points	Difference Points
	50	44	44	6

The reliability coefficient was 0.94, which denotes the reliability of the analysis.

Second, reliability across individuals. We assigned three experienced mathematics teachers, excluding those who previously determined the validity of the tool, to analyse both parts of the third-grade mathematics book and determine the mathematical concepts within it. Table 2 summarises the results.

Table 2. Results of content analysis by researchers and teachers.

Analyst	Number of Concepts	Agreement Points	Difference Points	Reliability Coefficient
Researchers	44 Mathematical Concepts			
Teacher 1	50	43	7	0.91
Teacher 2	47	42	5	0.92
Teacher 3	41	41	0	0.96

Reliability coefficient of the first analyser (Teacher 1) = 0.91. Reliability coefficient of the second analyser (Teacher 2) = 0.92. Reliability coefficient of the third analyser (Teacher 3) = 0.96.

The results indicate the reliability of the analysis. Concepts with less than 50% agreement were excluded, bringing the final number of concepts to 39. These concepts were then categorised into five main sections to build the diagnostic test: place value, mathematical calculations, measurements, geometry, and graphic representation.

4.6.2. Diagnostic Test

The diagnostic test consisted of 40 questions divided into five sections (place value, mathematical calculations, measurement, geometry, and graphic representation); the questions varied in type, consisting of multiple-choice, matching, and short-answer formats. The purpose of the diagnostic test was to collect data to measure the impact of each educational mode on fourth-grade students and compare this with the other mode.

The diagnostic test considerations were: scientific and linguistic accuracy in questions, comprehensiveness of the content, suitability regarding the level of students, providing instructions for the test, and language, where the instrument was prepared using the Arabic language so that the participants could understand the diagnostic test.

We measured the validity and reliability of the diagnostic test by following scientific research procedures and reviewing previous theses as follows. First, we discussed the diagnostic test with five academic mathematics faculty members from different universities and five experienced mathematics teachers to determine the face validity and appropriateness of the test content. Second, we applied the diagnostic test to an exploratory sample of 30 students from the fourth grade to find the difficulty coefficient. These were chosen from outside the study sample, but met the conditions for selecting the sample based on completion of the mathematics textbook in the third grade, their age, and social and cultural background.

According to [52], coefficients of difficulty denote the percentage of students who answered the questions incorrectly. Therefore, we calculated the difficulty coefficient of the test items by using the following equation:

$$\text{Difficulty coefficient} = \frac{\text{Wrong answers to the paragraph}}{\text{correct answers} + \text{wrong answers}}$$

We found that the coefficients of difficulty ranged between 0.51–0.27, with an average of 0.43. Therefore, all test items were acceptable, as they were within the reasonable limit of

difficulty decided by specialists, including [52], who preferred coefficients of difficulty to range between 20% to 80% and the test difficulty as a whole to be 50%.

Third, we calculated the discrimination coefficient. As per [52], the discrimination coefficient denotes the ability of the test item to distinguish between students who are excellent in the trait measured by the test and students who are weak. We found that the discrimination coefficient ranged between 0.27–0.64, with an average of 0.54. The accepted discrimination coefficient must be between 0.20–0.80; therefore, according to the diagnostic test average, all items of the test were acceptable.

Fourth, we determined the reliability of the instrument through the split-half method, where the test items were divided into halves (odd and even) and the correlation coefficient between the two halves was equal to 0.925. The length was then adjusted using the Spearman/Brown equation, following which the reliability coefficient was 0.961. This indicated that the diagnostic test had good reliability and could be used in this study.

5. Results and Discussion

The study employed quantitative data analysis techniques to generate answers to the following research questions.

5.1. What Are the Mathematical Concepts Included in the Diagnostic Test for Fourth-Grade Students?

The researchers analysed the mathematics book (parts one and two) for the third grade and identified 39 main mathematical concepts. The researchers only included the main mathematical concepts in the diagnostic test for the fourth-grade participants, which comprised the following five sections in Table 3:

Table 3. The main mathematical concepts for each of the five sections.

Section	Main Mathematical Concepts
Place value	Concepts of expanding pictures of numbers (verbal, analytic, standard)
	Concepts of comparing between numbers, using < or > or =
	The order of the numbers (concept of descending)
	Concepts of rounding (to the nearest thousand)
Mathematical calculations	Arithmetic operations (addition, subtraction, multiplication, division)
	Verbal problems in arithmetic operations (addition, subtraction, multiplication, division)
Measurement	Units of measurement (length, volume, and capacity)
	The concept of space
	The concept of the perimeter
Geometry	Concepts of geometric shapes
	Concepts of the sides of geometric shapes
Graphic representation	Graphs (*X* axis, *Y* axis, columns)
	Data representation (drawing, numerical, frequency)

In terms of the diagnostic test, we selected the main mathematical concepts in Table 3 to include in it. It is interesting to note that the mathematical concepts selected were

completely in agreement with those in [47], where the most important mathematical concepts for the fourth grade were identified.

5.2. How Effective Is the Face-to-Face Learning Mode in Enabling Fourth-Grade Students to Acquire Mathematical Concepts?

The researchers used Statistical Package for the Social Sciences (SPSS) platform to determine the average scores of face-to-face learning students in all sections:

Figure 1 indicates a normal distribution of the participant grades in the face-to-face learning mode, although slightly to the left; however, by reference to the Descriptive Statistics in Table 4, skewness was 0.925, which is less than 1, meaning that the sample had a normal distribution. Additionally, Table 4 shows a grade mean of 41 out of 50 in students' grades. Therefore, the result indicates that students who learned through the face-to-face learning mode were successful in the diagnostic test.

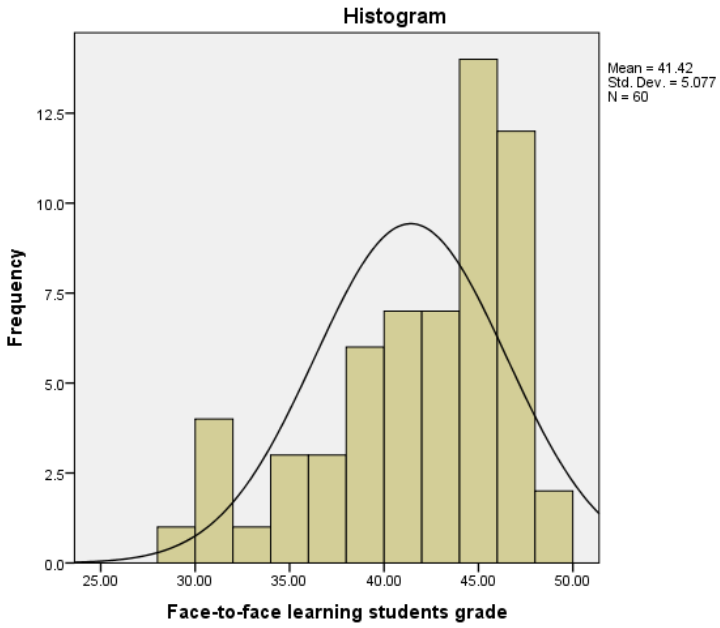

Figure 1. Normal distribution of the participant grades in the face-to-face learning mode.

Table 4. Descriptive statistics for face-to-face learning students.

	N	Mean		Std. Deviation	Skewness	
	Statistic	**Statistic**	**Std. Error**	**Statistic**	**Statistic**	**Std. Error**
Face-to-face learning students grade	60	41.4167	0.65540	5.07667	−0.925	0.309
Valid N (listwise)	60					

5.3. How Effective Is the Distance Learning Mode in Enabling Fourth-Grade Students to Acquire Mathematical Concepts?

We used the Statistical Package for the Social Sciences (SPSS) platform to determine the average scores of distance learning students in all sections.

Figure 2 indicates a normal distribution of the participants grades in the distance learning mode. Additionally, Table 5 shows a grade mean of 33.5 out of 50 in students' grades, showing that the students were successful in the diagnostic test but with a lesser grade mean than the face-to-face learning mode.

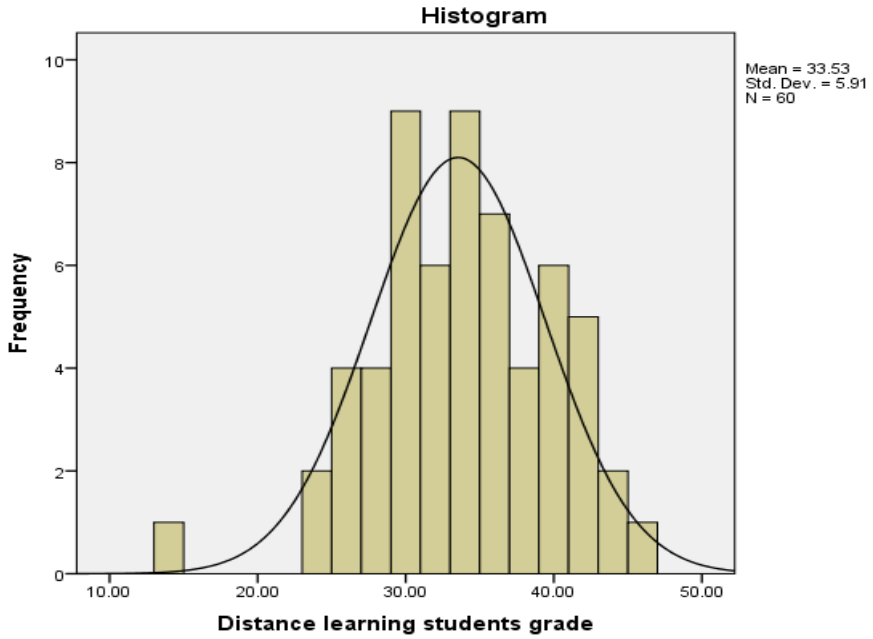

Figure 2. A normal distribution of the participants grades in the distance learning mode.

Table 5. Descriptive statistics for distance learning students.

	N	Mean		Std. Deviation	Skewness	
	Statistic	**Statistic**	**Std. Error**	**Statistic**	**Statistic**	**Std. Error**
Distance learning students' grade	60	33.5333	0.76301	5.91025	−0.422	0.309
Valid N (listwise)	60					

The current study contradicts [45], in which 11% fewer weaker students were found in the distance learning mode compared to the face-to-face learning mode, while we recorded a high grade for both modes, but with a slight difference in favour of the face-to-face learning mode.

This difference in the results could be due to the different ages of the samples, as in the other study the learners were older and described as independent learners more than primary school students.

5.4. What Is the Difference between the Effectiveness of Both Modes?

First: differences between groups in the concept of place values.

As shown in Table 6, when analysing the differences between the two research groups in the concept of place values, statistically significant differences were identified in the concepts of expanding pictures of numbers (verbal, analytic, standard) and comparing numbers ($p < 0.05$), where the differences were in favour of the group of students taught with the face-to-face mode. There were no statistically significant differences in the concepts of descending order and rounding to the nearest thousand (p-value > 0.05), indicating convergence of the two groups' scores on these variables.

Table 6. *T*-test of the differences between the two study groups (distance learning and face-to-face learning) in the concept of place values.

Variables	Groups	N	Mean	Std. Deviation	T-Value	*p*-Value *	Sig. Level	Hypothesis Testing
expanding pictures of numbers (verbal, analytic, standard)	face-to-face students	60	2.8000	1.10162	4.151	0.000	0.01	Reject
	distance learning students	60	1.9500	1.14129				
Compare numbers	face-to-face students	60	1.8167	0.43146	7.546	0.000	0.01	Reject
	distance learning students	60	0.9667	0.75838				
Descending order	face-to-face students	60	1.6000	0.52722	−0.349	0.728	No Sig.	Support
	distance learning students	60	1.6333	0.51967				
Rounding to the nearest thousand	face-to-face students	60	1.6167	0.52373	0.477	0.634	No Sig.	Support
	distance learning students	60	1.5667	0.62073				

* if *p*-value ≥ 0.01 = 0.01; if *p*-value from < 0.01 and ≥ 0.05 = 0.05; if *p*-value ≤ 0.05 = not sig.

This result contradicted with [11], in which it was found that the activities in the face-to-face learning mode were rated as less effective than those in the distance learning mode. However, according to [11], the level of engagement between teachers and face-to-face students was greater and more productive than engagement between teachers and distance learning students, which was in agreement with the current research, in which face-to-face students with direct communication achieved good grade in the diagnostic test.

Second: Differences between groups in the concept of mathematical calculations.

As shown in Table 7, when analysing the differences between the two research groups (distance education and face-to-face education) in the concept of mathematical calculations, there were statistically significant differences in basic arithmetic operations and verbal problems with arithmetic operations ($p < 0.05$) in favour of the students taught with the face-to-face learning mode.

Table 7. *T*-test of the differences between the two study groups (distance learning and face-to-face learning) in the concept of mathematical calculations.

Variables	Groups	N	Mean	Std. Deviation	T-Value	*p*-Value *	Sig. Level	Hypothesis Testing
Basic arithmetic operations	face-to-face students	60	4.9500	1.11119	8.296	0.000	0.01	Reject
	distance learning students	60	3.0500	1.38301				
Verbal problems with arithmetic operations	face-to-face student	60	3.4000	0.74105	5.543	0.000	0.01	Reject
	distance learning students	60	2.5500	0.92837				

* if *p*-value ≥ 0.01 = 0.01; if *p*-value from < 0.01 and ≥ 0.05 = 0.05; if *p*-value ≤ 0.05 = not sig.

There was a sharp contrast between the two learning modes in the mathematical calculations section, indicating that primary students need direct teaching in arithmetic

operations (addition, subtraction, multiplication, and division) to understand them better. Such variance could be due to the difficulty level of the concept, as [9] found that 83% of teachers admitted that it was difficult to explain complex scientific concepts.

This result aligns with [46], which found that in schools that had shifted to online classes and adopted a distance learning mode during COVID-19, the students were two months behind in their learning in mathematics.

Third: Differences between groups in the concept of measurement.

As shown in Table 8, when analysing the differences between the two research groups in the concept of measurement section, statistically significant differences were identified in units of measurement for length, volume and capacity ($p < 0.05$) in favour of the students who were taught with the face-to-face learning mode.

Table 8. *T*-test of the differences between the two study groups (distance learning and face-to-face learning) in the concept of measurement.

Variables	Groups	N	Mean	Std. Deviation	T-Value	*p*-Value *	Sig. Level	Hypothesis Testing
Units of measurement for length, volume, and capacity	face-to-face students	60	3.3500	0.86013	3.446	0.001	0.01	Reject
	distance learning students	60	2.7333	1.08716				
Space concept	face-to-face students	60	2.2833	0.84556	1.292	0.199	No Sig.	Support
	distance learning students	60	2.0833	0.84956				
Perimeter concept	face-to-face students	60	2.1500	0.95358	1.412	0.161	No Sig.	Support
	distance learning students	60	1.9000	0.98635				

* if *p*-value $\geq$ 0.01 = 0.01; if *p*-value from <0.01 and $\geq$0.05 = 0.05; if *p*-value $\leq$ 0.05 = not sig.

There were no statistically significant differences for space and perimeter ($p > 0.05$), indicating the convergence of the two groups' scores on these variables.

Fourth: Differences between groups in the concept of geometry.

As shown in Table 9, when analysing the differences between the two research groups (distance education and face-to-face education) in the concept of geometry section, there were statistically significant differences in the names of geometric shapes and concepts of the sides of geometric shapes ($p < 0.05$) in favour of students taught with the face-to-face learning mode.

This result contrasts with that of [44], who found that students taking online courses reported better understanding of the course structure, and their final grades were higher than those students undertaking face-to-face learning. This could be because the participants in [44] were higher education students, who are characterised by the ability to be self-learners, in contrast to the primary-stage students in this study, who are characterised by a lower level of maturity, which, according to [29], can impede the success of students on an online programme.

Fifth: Differences between groups in the concept of graphic representation.

As shown in Table 10, when analysing the differences between the two research groups (distance education and face-to-face education) in the concept of graphic representation section, there were statistically significant differences in data visualisation ($p < 0.05$) in favour of the group of students taught with the face-to-face learning mode.

Table 9. *T*-test of the differences between the two study groups (distance learning and face-to-face learning) in the concept of geometry.

Variables	Groups	N	Mean	Std. Deviation	T-Value	*p*-Value*	Sig. Level	Hypothesis Testing
Names of geometric shapes	face-to-face students	60	3.7333	0.57833	5.604	0.000	0.01	Reject
	distance learning students	60	2.8167	1.12734				
Concepts of the sides of geometric shapes	face-to-face students	60	4.9333	1.03934	2.419	0.017	0.05	Reject
	distance learning students	60	4.4000	1.35547				

* if *p*-value $\geq$ 0.01 = 0.01; if *p*-value from <0.01 and $\geq$0.05 = 0.05; if *p*-value $\leq$ 0.05 = not sig.

Table 10. *T*-test of the differences between the two study groups (distance learning and face-to-face learning) in the concept of graphic representation.

Variables	Groups	N	Mean	Std. Deviation	T-Value	*p*-Value *	Sig. Level	Hypothesis Testing
The graph	face-to-face students	60	5.1500	1.05485	1.944	0.054	No Sig.	Support
	distance learning students	60	4.7167	1.36657				
Data Visualisation	face-to-face students	60	3.6333	0.58125	3.519	0.001	0.05	Reject
	distance learning students	60	3.1667	0.84706				

* if *p*-value $\geq$ 0.01 = 0.01; if *p*-value from <0.01 and $\geq$0.05 = 0.05; if *p*-value $\leq$ 0.05 = not sig.

There were no statistically significant differences with respect to the graph ($p > 0.05$), indicating convergence of the two groups' scores on this variable.

The general result of this study is consistent with [49], where the results show that the effect of the chosen learning mode is uneven, and students generally achieved a better level using a distance learning mode than a face-to-face learning mode.

6. Conclusions

With the spread of COVID-19, the Bahrain government ensured that it considered the conditions of all students and did not shut down educational institutions completely. Instead, it offered students two learning mode options: continuing their learning in a face-to-face mode or changing to a distance learning mode (online). As educators, we pay attention to the type of learning mode, because it determines how the educational process proceeds and the extent to which students acquire the required competencies.

The current research compared the effectiveness of each mode in helping fourth-grade primary students acquire mathematical concepts in five sections (place value, mathematical calculations, measurement, geometry, graphic representation).

The results offer interesting implications for learning modes, indicating a variance between the average scores in all sections (place values, mathematical calculations, graphing, measurement, and geometry) for fourth-grade students who studied through either distance learning or face-to-face learning, leading us to conclude that the learning mode affects the acquisition of mathematical concepts, with each section detailed as follows:

First, the contrast between the two learning modes was almost non-existent (similar) for the following concepts: descending order and rounding to the nearest thousand from

the place value section; space and perimeter from the measurement section; and graphs from the graphic representation section.

Second, in the 'place values' section, for the concepts of expanding pictures of numbers (verbal, analytic, standard) and comparing numbers, the differences were in favour of the group of students taught in a face-to-face mode, while there were no statistically significant differences for the concepts of descending order and rounding to the nearest thousand.

Third, in the 'mathematical calculations' section, there was a sharp contrast between the two learning modes in this section in favour of face-to-face learning.

Fourth, when it came to 'measurement', there were statistically significant differences identified in the concept of units of measurement for length, volume, and capacity in favour of the students who were taught in a face-to-face learning mode, while there were no statistically significant differences for space and perimeter.

Fifth, in the 'geometry' section, there were statistically significant differences in the concepts of names of geometrical shapes and sides in favour of students taught in the face-to-face learning mode.

Finally, in the 'graphic representation' section, statistically significant differences in data visualization were noticed in favour of the group of students taught in the face-to-face learning mode. Additionally, there were no statistically significant differences with the 'graph concept' between the two groups. It is important to mention that the scores for all of these mathematical concepts were almost similar in both the distance learning and face-to-face modes, which leads us to wonder why this should be the case.

7. The Significance of the Research

This research is significant for the following reasons. First, it can enrich educational libraries with a contemporary topic on the effect of distance learning during COVID-19. Second, it can provide useful insights regarding the effects of distance learning and face-to-face learning in enabling primary students to acquire mathematics concepts. Third, it can be used to instruct educational institutions and decision makers on the effects of distance learning and face-to-face learning on the acquisition of mathematics concepts by primary students. Finally, we have provided useful recommendations that will benefit researchers conducting research on this topic.

8. Limitations

Although this study was carefully prepared, it still faced a number of limitations, which did not have a negative effect on the findings. These can be summarised as follows: The results are specific to one school and to the elementary stage only. However, we believe that this city was a good place to conduct this study due to its large population, which is drawn from different parts of the Kingdom of Bahrain. In regard to the elementary stage, the groundwork for future learning and future skills is laid by primary education because the skills and values that are instilled there are absolutely foundational. Primary education serves as the base which students build upon during further schooling, and hence the choice of elementary school is important. Moreover, this study omitted students' views, readiness, and acceptance of the study in both modes (distance learning and face-to-face learning). Furthermore, the study did not consider the details of preparing teachers for distance learning in the use of technology and devices.

9. Suggestions

In light of our findings, we recommend the following: Firstly, future studies could be extended to other areas of the education field. Secondly, this study could be replicated and extended to include middle and high schools. Thirdly, researchers could investigate the reasons for the difference in academic progress for each learning mode. Fourthly, researchers could investigate the reasons for the success of each learning mode in acquiring mathematical concepts. Finally, researchers could compare learning modes in mathematical skills or mathematical power in addition to mathematical concepts.

Author Contributions: Conceptualization, M.S.A. and E.A.T.; methodology, M.S.A. and E.A.T.; validation, M.S.A. and E.A.T.; formal analysis, M.S.A. and E.A.T.; investigation, M.S.A. and E.A.T.; resources, M.S.A. and E.A.T.; data curation, M.S.A. and E.A.T.; writing—original draft preparation, M.S.A. and E.A.T.; writing—review and editing, M.S.A. and E.A.T.; visualization, M.S.A. and E.A.T.; supervision, M.S.A. and E.A.T.; project administration, M.S.A. and E.A.T. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Ethical review and approval were waived for this study because we have obtained permission from the head of the school and students' parents before the collection of data for the study (attached in our study), and because our study are of no risk and use only non-identifiable data about human beings.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data that support the findings of this study will be made available from the authors upon reasonable request.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A


KINGDOM OF BAHRAIN
Ministry of Education
مملكة البحرين
وزارة التربية والتعليم

بسم الله الرحمن الرحيم

إلى من يهمه الأمر، تحية طيبة وبعد ..

يقوم فريق البحث المتمثل في الباحث منصور بن صالح العبدالعزيز والباحثة إيناس بنت أنور عبدالله بعمل دراسة بعنوان:

"A Comparative Study of The Effects of Distance Learning and Face-to-Face Learning During (Covid-19) Pandemic on Gaining Mathematical Concepts for The Primary Students in Kingdom of Bahrain"

ولتحقيق هدف الدراسة المتمثل بمُقارنة فعالية التعلم وجهاً لوجه والتعلم –عن بُعد– في مُساعدة طلاب الصف الرابع الابتدائي على اكتساب المفاهيم الرياضية في مملكة البحرين، سيتم تطبيق أداة الدراسة (اختبار مسحي في المفاهيم الرياضية) على طلاب الصف الرابع الابتدائي في مدرسة الدير الابتدائية للبنين. وعليه، أنا مديرة المدرسة أ. عائشة محمد المهزع أوافق على جمع الاستجابات من أبناءنا الطلبة في الاختبار المسحي لغرض البحث العلمي فقط، سائله المولى عزّ وجلّ التوفيق والسداد للباحثين في مجال التطوير التربوي والبحث العلمي.

وتفضلوا بقبول فائق الاحترام والتقدير..

مديرة المدرسة: أ. عائشة محمد المهزع

التوقيع:

١٥/١٢/٢٠٢٢م

مملكة البحرين – وزارة التربية والتعليم – مدرسة الدير الابتدائية للبنين

Dair.pr.b@moe.gov.bh :الإيميل مملكة البحرين – المحرق – الدير – مجمع 233 – شارع ريا – مبنى 244 هاتف: 17323818

T: 00973 17323818 Kingdom of Bahrain – Muharraq – AlDair – Block 233 – Road Raya – Building 244 E-mail: Dair.pr.b@moe.gov.bh

Figure A1. An approval in Arabic language from the school administration to conduct the study.

KINGDOM OF BAHRAIN

Ministry of Education

مَمْلَكَةُ البَحْرَيْن

وَزَارَةُ التَّرْبِيَةِ وَالتَّعْلِيم

To whom it may concern,

The research team represented by the researcher Mansour Saleh Alabdulaziz and the researcher Enas Anwar Abdullah Taifour is conducting a study titled by:

"A Comparative Study of The Effects of Distance Learning and Face-to-Face Learning During (Covid-19) Pandemic on Gaining Mathematical Concepts for The Primary Students in Kingdom of Bahrain"

By refer to the objective of this study which is compare the effectiveness of (face-to-face learning and distance learning) in helping 4th grade primary students acquire mathematical concepts.

Accordingly, I Aisha Mohammed Al-Mehza as a principle of Al-Dair Primary Boys School, agree for the researchers to collect the responses from our students in the diagnostic test for the purpose of scientific research, and wishing success and reimbursement for researchers in the field of scientific research.

School principal: T. Aisha Mohammed Al-Mehza

Signature:

٢٠٢٢/١٢/١٥

School stamp:

مملكة البحرين – وزارة التربية والتعليم
مدرسة الدير الابتدائية للبنين

الإيميل: Dair.pr.b@moe.gov.bh مبنى 244 – شارع ريا – مجمع 233 – الدير – المحرق – مملكة البحرين هاتف: 17323818

T: 00973 17323818 Kingdom of Bahrain – Muharraq – AlDair – Block 233 – Road Raya – Building 244 E-mail: Dair.pr.b@moe.gov.bh

Figure A2. An approval in English language from the school administration to conduct the study.

Appendix B

KINGDOM OF BAHRAIN
Ministry of Education

مملكة البحرين
وزارة التربية والتعليم

To whom it may concern,

The research team represented by the researcher Mansour Saleh Alabdulaziz and the researcher Enas Anwar Abdullah Taifour is conducting a study titled by:

"A Comparative Study of The Effects of Distance Learning and Face-to-Face Learning During (Covid-19) Pandemic on Gaining Mathematical Concepts for The Primary Students in Kingdom of Bahrain"

By refer to the objective of this study which is compare the effectiveness of (face-to-face learning and distance learning) in helping 4th grade primary students acquire mathematical concepts.

Accordingly, we, the parents of the fourth grade students at Al-Dair Primary Boys School, agree for the researchers to collect the responses from our students in the diagnostic test for the purpose of scientific research, and wishing success and reimbursement for researchers in the field of scientific research.

Signed on their behalf, in the Council of Fathers:

Name	Mobile Number	E-mail	Signature
Zainab Abd Rsuel Isa	+97333456612	zainab3687@icloud.com	

School stamp:

Dair.pr.b@moe.gov.bh :الإيميل 244 مبنى – شارع ريا – مجمع 233 – الدير – المحرق – مملكة البحرين 17323818 :هاتف
T: 00973 17323818 Kingdom of Bahrain – Muharraq – AlDair – Block 233 – Road Raya – Building 244 E-mail: Dair.pr.b@moe.gov.bh

Figure A3. An approval in English language from the parents of the fourth-grade students at Primary Boys School, signed on their behalf by one of the parents who participated in the council of fathers.

KINGDOM OF BAHRAIN
Ministry of Education

مَمْلَكَةُ البَحْرَيْن
وَزَارَةُ التَّرْبِيَةِ وَالتَّعْلِيم

بسم الله الرحمن الرحيم

إلى من يهمه الأمر، تحية طيبة وبعد ..

يقوم فريق البحث المتمثل في الباحث منصور بن صالح العبدالعزيز والباحثة إيناس بنت أنور عبدالله بعمل دراسة بعنوان:

"A Comparative Study of The Effects of Distance Learning and Face-to-Face Learning During (Covid-19) Pandemic on Gaining Mathematical Concepts for The Primary Students in Kingdom of Bahrain"

ولتحقيق هدف الدراسة المتمثل بمُقارنة فعالية التعلم وجهاً لوجه والتعلم –عن بُعد– في مُساعدة طلاب الصف الرابع الابتدائي على اكتساب المفاهيم الرياضية في مملكة البحرين، سيتم تطبيق أداة الدراسة (اختبار مسحي في المفاهيم الرياضية) على طلاب الصف الرابع الابتدائي في مدرسة الدير الابتدائية للبنين. وعليه، نحنُ أولياء أمور طلاب الصف الرابع الابتدائي في مدرسة الدير الابتدائية للبنين نوافق على جمع الاستجابات من أبنائنا الطلبة في الاختبار المسحي لغرض البحث العلمي فقط، سائلين المولى عزّ وجلّ التوفيق والسداد للباحثين في مجال التطوير التربوي والبحث العلمي.

عنهُم، في مجلس الآباء للصف الرابع الابتدائي:

الاسم	الهاتف	الإيميل	التوقيع
زينب عبدالرسول عيسى	+97333456[illegible]	Zainab3687@klou[illegible]	

وتفضلوا بقبول فائق الاحترام والتقدير..

مملكة البحرين – وزارة التربية والتعليم
مدرسة الدير الابتدائية للبنين
ختم المدرسة:

هاتف: 17323818 مملكة البحرين – المحرق – الدير – مجمع 233 – شارع ريا – مبنى 244 الإيميل: Dair.pr.b@moe.gov.bh
T: 00973 17323818 Kingdom of Bahrain – Muharraq – AlDair – Block 233 – Road Raya – Building 244 E-mail: Dair.pr.b@moe.gov.bh

Figure A4. An approval in Arabic language from the parents of the fourth-grade students at Primary Boys School, signed on their behalf by one of the parents who participated in the council of fathers.

References

1. United Nations Educational, Scientific and Cultural Organization. Education in the Time of COVID-19. 2020. Available online: https://unesdoc.unesco.org/ark:/48223/pf0000374075_eng/PDF/374075eng.pdf.multi (accessed on 12 May 2022).
2. Al-khaleej, A. Ministry of Education" the Choice between "Face-to-Face Learnind" and "Distance Learning. 2020. Available online: http://www.akhbar-alkhaleej.com/news/article/1230510 (accessed on 1 June 2022).
3. Gautam, P. Advantages and Disadvantages of Online Learning. In E-Learning Industry. 2000. Available online: http://www.elearningindustry.com (accessed on 2 June 2022).
4. Mukhtar, K.; Javed, K.; Arooj, M.; Sethi, A. Advantages, Limitations and Recommendations for online learning during COVID-19 pandemic era. *Pak. J. Med. Sci.* **2020**, *36*, S27. [CrossRef]
5. Hui, W.; Hu, P.J.H.; Clark, T.H.K.; Tam, K.Y.; Milton, J. Technolo gy-Assisted Learning: A Longitudinal Field Study of Knowledge Category, Learning Effectiv eness and Satisfaction in Language Learning. *J. Comput. Assist. Learn.* **2008**, *3*, 245–259.
6. Reisetter, M.; LaPointe, L.; Korcuska, J. The Impact of Altered Realities: Implications of Online Delivery for Learners' Interactions, Expectations, and Learning Skills. *Int. J. E-Learn.* **2007**, *1*, 55–80.
7. Johnson, D.; Sutton, P.; Poon, J. Face-to-Face vs CMC: Student Communicati on in a Technologically Rich Learning Environment. 2000. Available online: https://www.researchgate.net/publication/2504229_Face-to-Face_vs_CMC_Student_Communication_in_a_Technologically_Rich_Learning_Environment (accessed on 15 May 2022).
8. Albilad Newspaper. The Minister of Education, 75 Thousand Students Registered in Face-to-Face Learning, and Infection Does Not Mean a Total Closure. 2021. Available online: https://albiladpress.com/news/2021/4706/bahrain/722028.html (accessed on 20 July 2022).
9. Ebohon, O.; Obienu, A.C.; Irabor, F.; Amadin, F.; Omoregie, E. Evaluating the impact of COVID-19 pandemic lockdown on education in Nigeria: Insights from teachers and students on virtual/online learning. *Bull. Natl. Res. Cent.* **2021**, *45*, 76. Available online: https://europepmc.org/articles/pmc8057660/bin/42269_2021_538_moesm1_esm.docx (accessed on 20 May 2022). [CrossRef]
10. Electronic Government. Economic Vision 2030. 2021. Available online: https://cutt.us/iAD9I (accessed on 12 May 2022).
11. Laura, A.D.; Florentino, B.E. Are the Functions of Teachers in e-Learning and Face-to-Face Learning Environments Really Different? *J. Educ. Technol. Soc.* **2009**, *12*, 331–343. Available online: https://library.iau.edu.sa/scholarly-journals/are-functions-teachers-e-learning-face/docview/1287039129/se-2 (accessed on 20 May 2022).
12. Coates, D.; Humphreys, B.R.; Kane, J.; Vachris, M.A. No significant distance between face to face and online instruction: Evidence from principles of economics. *Econ. Educ. Rev.* **2004**, *23*, 533–546. Available online: https://www.cerge-ei.cz/pdf/events/papers/011101_t.pdf (accessed on 12 May 2022). [CrossRef]
13. Barbour, M.K. The promise and the reality: Exploring virtual schooling in rural jurisdictions. *Educ. Rural Aust.* **2011**, *21*, 1–20.
14. Bergdahl, N.; Nouri, J. COVID-19 and Crisis-Prompted Distance Education in Sweden. *Tech. Know. Learn.* **2021**, *26*, 443–459. [CrossRef]
15. Lauzon, A. Integrating computer-based instruction with computer conferencing: An evaluation of a model for designing online education. *Am. J. Distance Educ.* **1992**, *6*, 32–46. [CrossRef]
16. Tebeaux, E. Technical writing by distance: Refocusing the pedagogy of technical communication. *Tech. Commun. Q.* **1995**, *4*, 365–395. [CrossRef]
17. Keegan, D. *Foundations of Distance Education*, 3rd ed.; Routledge: London, UK, 1996.
18. Peters, O. *Distance Education in Transition*; Biblioteks-and Informations System der Universität Oldenburg: Oldenburg, Germany, 2002.
19. Holmberg, B. *The Feasibility of a Theory of Teaching for Distance Education and a Proposed Theory*; ZIFF Papiere 60; Institut für Fernstudienforschung: Hagen, Germany, 1985.
20. Perraton, H. *Open and Distance Learning in the Developing World*; Routledge: London, UK, 2000.
21. Koohang, A.; Harman, K. Open Source: A Metaphor for E-Learning. *Inf. Sci. Int. J. Emerg. Transdiscipl.* **2005**, *8*, 75–86.
22. Hung, D.; Nichani, M. Constructivism and e-learning: Balancing between the individual and social levels of cognition. *Educ. Technol.* **2001**, *41*, 40–44.
23. Woolfolk, A.E. *Educational Psychology*; Allyn and Bacon: Boston, MA, USA, 1993.
24. Beyth-Marom, R.; Saporta, K.; Caspi, A. Synchronous vs. asynchronous tutorials: Factors affecting students' preferences and choices. *J. Res. Technol. Educ.* **2005**, *37*, 245–262. [CrossRef]
25. Kinsel, E.; Cleveland-Innes, M.; Garrison, R. Student role adjustment in online environments: From the mouths of online babes. In Proceedings of the 20th Annual Conference of Distance Teaching and Learning, Madison, WI, USA, 5–7 August 2004.
26. Aljawarneh, S.A. Reviewing and exploring innovative ubiquitous learning tools in higher education. *J. Comput. High Educ.* **2020**, *32*, 57–73. [CrossRef]
27. Lara, J.A.; Aljawarneh, S.; Pamplona, S. Special issue on the current trends in E-learning Assessment. *J. Comput. High. Educ.* **2020**, *32*, 1–8. [CrossRef]
28. Lizcano, D.; Lara, J.A.; White, B.; Aljawarneh, S. Blockchain-based approach to create a model of trust in open and ubiquitous higher education. *J. Comput. High. Educ.* **2020**, *32*, 109–134. [CrossRef]
29. Maeroff, G.I. *A Classroom of One: How Online Learning is Changing Our Schools and Colleges*; Palgrave Macmillan: New York, NY, USA, 2003.

30. Barbour, M.K. Today's student and virtual schooling: The reality, the challenges, the promise. *J. Distance Learn.* **2009**, *13*, 5–25.
31. Moore, M.G. Theory of transactional distance. In *Theoretical Principles of Distance Education*; Keegan, D., Ed.; Routledge: New York, NY, USA, 1993.
32. Svinicki, M.; McKeachie, W.J. *Strategies: Research, and Theory for College and University Teachers*, 13th ed.; Wadsworth: Belmont, CA, USA, 2011.
33. Lambert, C. Twilight of the lecture. *Harv. Mag.* **2012**, *114*, 23–27.
34. Millis, B.J. *Active Learning Strategies in Face-to-Face Courses*; IDEA Paper No. 53; The IDEA Center: Cleveland, OH, USA, 2012.
35. Bandara, D.; Wijekularathna, D.K. Comparison of Student Performance under TwoTeaching Methods: Face to Face and Online. *Int. J. Educ. Res.* **2017**, *12*, 69–79.
36. Novak, J. *Learning, Creating, and Using Knowledge*; Lawrence Erlbaum Association: Mahwah, NJ, USA, 1998.
37. Hestenes, D. *Cited in Hanford, E., Physicists Seek to Lose the Lecture as a Teaching Tool*; NPR Broadcast of American Radio Works; 2012; Available online: http://www.npr.org/2012/01/01/144550920/physicists-seek-to-lose-the-lecture-asteaching-tool (accessed on 6 January 2023).
38. Weimer, M.E. *Learner-Centered Teaching: Five Key Changes to Practice*; Jossey-Bass: San Francisco, CA, USA, 2002.
39. Bonwell, C.C.; Eison, J.A. *Active Learning: Creating Excitement in the Classroom*; ASHE-ERIC Higher Education Report; School of Education and Human Development, George Washington University: Washington, DC, USA, 1991.
40. Stern, B.S. A comparison of online and face-to-face instruction in an undergraduate foundations of American Education Course. *Contemp. Issues Technol. Teach. Educ.* **2004**, *4*, 196–213.
41. Solimeno, A.; Mebane, M.E.; Tomai, M.; Francescato, D. The influence of students and teachers characteristics on the efficacy of face-to face and computer supported collaborative learning. *Comput. Educ.* **2008**, *51*, 109–128. [CrossRef]
42. Wuensch, K.; Aziz, S.; Ozan, E.; Kishore, M. Pedagogical Characteristics of Online and Face-to-Face Classes. *Int. J. E-Learn.* **2008**, *7*, 523–532.
43. Ginns, P.; Ellis, R. Quality in blended learning: Exploring the relations between on-line and face-to-face teaching and learning. *Internet High. Educ.* **2007**, *10*, 53–64. [CrossRef]
44. Soffer, T.; Nachmias, R. Effectivness of learning in online academic courses compared with face-to-face courses in higher education. *J. Comput. Assist. Learn.* **2018**, *34*, 534–543. [CrossRef]
45. El Refae, G.A.; Kaba, A.; Eletter, S. The Impact of Demographic Characteristics on Academic Performance: Face-to-Face Learning versus Distance Learning Implemented to Prevent the Spread of COVID-19. *Int. Rev. Res. Open Distrib. Learn.* **2021**, *22*, 91–110.
46. Gore, J.; Fray, L.; Miller, A.; Harris, J.; Taggart, W. The impact of COVID-19 on student learning in New South Wales primary schools: An empirical study. *Aust. Educ. Res.* **2021**, *48*, 605–637. [CrossRef]
47. Al-Biyari, A.S. The Effect of Using the Posner Strategy in Modifying the Misperceptions of Mathematical Concepts among the Fourth-Grade Female Students. Islamic University of Gaza. 2012. Available online: http://hdl.handle.net/20.500.12358/18084 (accessed on 12 May 2022).
48. Edelman, J. How Preservice Teachers Use Children's Literature to Teach Mathematical Concepts: Focus on Mathematical Knowledge for Teaching. *Int. Electron. J. Elem. Educ.* **2017**, *9*, 741–752.
49. Iglesias-Pradas, S.; Hernández-García, A.; Chaparro-Peláez, J.; Prieto, J.L. Emergency remote teaching and students' academic performance in higher education during the COVID-19 pandemic: A case study. *Comput. Hum. Behav.* **2021**, *119*, 106713. [CrossRef]
50. Silverman, D. *Doing Qualitative Research: A Practical Handbook*; SAGE Publications: London, UK, 2000.
51. Creswell, J.W. *Research Design: Qualitative, Quantitative and Mixed Methods Approach*, 2nd ed.; Sage Publications: London, UK, 2003.
52. Abu Libdeh, S. *Principles of Educational Measurement and Evaluation*; Cooperative Press Workers Association: Jordan, Amman, 1982.