



## Beyond COVID-19 Lockdowns: Rethinking Mathematics Education from a Student Perspective

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### Abstract

The COVID-19 pandemic has recently reshaped education and life around the world. Undoubtedly, the return to face-to-face learning has been affected after two years of distance learning. However, research that focuses on post-COVID-19 is still limited. Therefore, this study investigates how students perceive the experience of returning to face-to-face learning after distance learning within the context of the United Arab Emirates (UAE). It emphasizes the possibilities and challenges that could be faced in improving face-to-face mathematics education. This study applied an exploratory sequential mixed-method approach, which involved collecting qualitative data from 13 students through a focus group, and then quantitative data was collected from 243 Cycle 2 and 3 students. The qualitative data were coded and analyzed thematically, while descriptive analysis was used to analyze the quantitative data. The qualitative and quantitative results revealed consensus on the main challenges that students experience as they return to face-to-face learning. On top of these challenges are students' lack of study skills, excessive use of technology, and high levels of math test anxiety. Research findings showed students' preference for face-to-face learning while adding some aspects of distance learning. The results of this study are also expected to be a reference in the development of a new sustainable paradigm of face-to-face learning and as study material for subsequent research related to rethinking math education after COVID-19.

### Keywords:

COVID-19;  
Face-to-Face Learning;  
Online Learning;  
Mathematics.

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## 1- Introduction

The COVID-19 pandemic has caused massive disruption to education systems around the world, prompting institutions to adapt to distance learning methods quickly. COVID-19 marks a shift in teaching from in-person to distance education [1]. Distance learning is not a new term in education; it has been implemented in the last two decades, and it is known by several terms, such as online learning or e-learning, as all these terms are usually used interchangeably. This shift to distance learning had mixed effects on these educational institutions, although this effect was almost negative [2]. The sudden movement to this distance mode of learning was combined with challenges and difficulties in the field of education [3]. For example, Borba [4] stated that there is a growing threat of social inequality in schools, noting that access issues prevent some students from attending certain schools and reinforce social inequality. On the other hand, as time passed, the implementation of online learning became better, and its positive effects began to emerge, such as increased mastery of digital literacy despite previously having to study it as part of the curriculum [2]. Furthermore, many students prefer to learn remotely because they do not have to leave their homes. Students can learn individually without being constrained by space or time [5].

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The pandemic has had a significant impact on mathematics education around the world, and unprecedented circumstances require quick responses [6]. Working and learning online requires teachers and students to make considerable changes to their normal teaching and learning approaches. For example, the learners' emphasis on learning mathematical knowledge was delayed by their familiarization with new technologies [7]. However, distance learning has a positive impact on mathematics education. According to Mulenga and Marbán [8], present research indicates that mathematics sessions are less formal, which can boost student learning by establishing a more relaxed learning environment. This transition has also changed the assessment methods teachers use to assess their students. Consequently, differences in students' grades are expected [9].

The United Arab Emirates (UAE), like many other countries, has undergone a major shift towards distance learning to preserve educational continuity while prioritizing public health and safety. The UAE's schools started a Learning Management System (LMS) for learning and assessment resources before the pandemic hit the world. Therefore, the burden of switching to distance learning is a little lighter for UAE schools, as they did not start from scratch. However, this sudden transformation caused several challenges, such as online course delivery, a lack of interaction with peers and teachers, and time management.

After the COVID-19 outbreak led to a complete lockdown, two years later, things are slowly returning to normal as the pandemic subsides. Closed schools were reopened, and face-to-face learning resumed gradually. The reopening of schools is welcomed for several reasons, including the fact that some habits and skills are difficult to teach through online learning [2]. However, this shift from online to face-to-face learning is not without challenges, as students may face some difficulties in adapting to face-to-face learning. The complications faced when returning to a face-to-face stage after COVID-19 make teachers and students feel as if they are entering a new setting that they have never experienced before. They want to return to pre-pandemic conditions, but they feel left behind and need to accelerate their learning process. They are also unable to fully implement the existing teaching technique, which has been in place for the previous two years. When returning to face-to-face learning after COVID-19, students may still face challenges in mathematics due to prior issues such as poor internet access, study habits, and the impact of distance learning on academic performance [10]. Students suffered an educational loss due to the continued closure, which makes them face great difficulty resuming their studies after this gap [11].

### *1-1-Purpose of the Study*

Extensive research has been done on education during the COVID-19 pandemic, focusing on many features of distance learning [12], including students' performance [13], learning loss [14], and students' well-being [15]. Stress and dropout [16], mathematics anxiety [17], while some research compared between the pre-pandemic and pandemic math achievement [18]. Conversely, not much focus has been given to what happened in education after the pandemic subsided. Most of the focus after the pandemic was given to the university level on specific aspects such as the benefit of mathematics learning resources [19] and the students' desire to use online learning after the pandemic [20]. While less research focused on the lived experience after the pandemic, such as Novita et al. [14] focused on the lecturers' experience and Plakhotnik et al. [21] on the students' experience. However, to the researcher's knowledge, none were found to study the UAE's students' experiences.

Based on the above background and in response to United Nations calls to reimagine education after COVID-19 [22], reflecting on the insights gained from online education is crucial. Consequently, this research aims to describe the teaching and learning processes that have taken place in the UAE after the COVID-19 pandemic. To this end, and to identify aspects of mathematics education that have been affected by the pandemic and that may be reduced to ensure continuity in the future, this study aims to fill the gap by investigating students' perceptions of the shift back to face-to-face learning. Students' perspectives and experiences on these concerns could provide valuable insights for rethinking math education post-COVID-19 and establishing a new sustainable paradigm. This study may also contribute to the development of policies and strategies aimed at improving the quality of education. Consequently, the current study adds excellence and novelty to the field of education.

### *1-2-Research Questions*

This study examines how students perceive their experience of returning to face-to-face mathematics education from online learning after COVID-19. As a result, this study looked more closely at the following research questions:

- **RQ1:** What are students' perceptions of transitioning back to face-to-face learning after COVID-19 subsides?
- **RQ2:** What elements of online learning must be preserved to enhance face-to-face education?
- **RQ3:** Is there any statistically significant difference in the mathematics challenges to go back to face-to-face learning between Cycle 2 and Cycle 3 students?
- **RQ4:** What type of education is most beneficial for students to study?

## 2- Literature Review

### 2-1- *The Impact of Online Education throughout the COVID-19 Lockdown*

The students' opinions varied between supporters and opponents of online learning. According to Chaudhary [23], the significance of online learning lies in its ability to facilitate more efficient self-learning. Students can choose how much time they spend studying or reviewing the content they are learning until they feel confident in their understanding. Many students prefer to learn remotely because they do not have to leave their homes [5]. Moreover, online learning benefits students by improving their understanding of digital literacy [2]. Another advantage of effective online learning is the provision of direct feedback regarding learning achievement and progress, in addition to the essential nonverbal communication between students and teachers [24]. Moreover, some students prefer online learning because of the flexible assessments [25, 26].

The pandemic has led to the widespread adoption of online learning by students, parents, and schools. This shift has been facilitated by improved support facilities and infrastructure [2]. Similar findings were made by Petillion & McNeil [7], who discovered that first-year engineering students enrolled in a mathematics course felt that online learning was advantageous in a variety of ways, including the flexibility it offered for learning and the accessibility of media resources. This indicates that students prefer to learn according to their schedules rather than being limited to traditional classroom schedules. They also believe that resources available at any time can help them understand the material, even if they cannot attend class on time. On the other hand, Petillion & McNeil [7] lecturers maintain total control over the academic integrity of their lessons in traditional classroom settings. Teachers' authority over the teaching and assessment process is diminished in online remote learning. Finally, Petillion & McNeil [7] indicated that for a smooth transition to online learning, students typically require some time to get adjusted.

In contrast, Fauzi & Sastra Khusuma [27] argued that online learning is conducted incorrectly and ineffectively. They provide several reasons for this, such as inadequate internet access, teachers' difficulties incorporating online learning, and a dearth of parental involvement. As stated by Adnan [28], the efficacy of online learning is compromised by poor internet access, a lack of technological advancements, and a lack of interaction between teachers and students. Additionally, Chaudhary [23] asserts that online learning is more concerned with the classroom setting during the COVID-19 pandemic than it is with assisting students in developing their abilities and becoming ready for the future. Moreover, students also said that group projects were challenging to do online and that in-person instruction was essential for learning effectively [6, 28]. Additionally, according to Amedu & Hollebrands [29], teachers brought up the challenges of getting feedback from students because of students' lack of participation. Teachers stated in Martin et al.'s [30] study that the major problem in online learning was the usage of general technologies, which weren't appropriate for mathematics. Research by Haser et al. [31] revealed several reasons for the decline in mathematics learning during the COVID-19 pandemic, including the low family socioeconomic level, low student participation, instructors' restricted use of mathematical teaching techniques, and teachers' lack of collaboration.

The investigation into how COVID-19 affects education is a continuous endeavor. Therefore, it is critical to emphasize online opportunities while also learning from their challenges. Paea et al. [32] proposed a taxonomy that includes seven challenges: lack of support for online learning; difficulties with the delivery of online courses; managing time and workload; problems with learning management systems; insufficient face-to-face interaction; financial difficulties; and internet challenges. This classification may aid in analyzing online learning initiatives. In summary, the COVID-19 pandemic had a mixed effect on students' learning experiences because of distance learning. Nonetheless, understanding this effect is crucial to assisting students in returning to face-to-face learning.

### 2-2- *Transition Back from Distance Learning to Face-to-Face Learning after COVID-19*

Following a decline in COVID-19 cases, face-to-face education replaced distance learning in the 2022–2023 school year. To determine whether online learning techniques could be sustained after COVID-19, Jamilah and Fahyuni [2] conducted a comprehensive review of the literature. They concluded that the adoption of online learning in the post-COVID period is supported in 76% of the publications studied, with various modifications that must be implemented. Sixty percent of these articles claim that blended learning is the best alternative. implementing learning and teaching [33]. The concept of blended learning is not new to students. Students around the world have long demanded flexibility in mathematics learning environments, so the idea of blended learning is not new to them [34].

The transition between educational models is not easy, and students seem to have conflicting opinions about it. In one sense, students were pleased with their online education and indicated that they would be willing to continue taking classes online in the future [35]. Similar findings were found by Chaudhary [23]. Students think online learning platforms are effective and cannot imagine using any other method for their educational experience. Nevertheless, even with all the advantages of virtual education, there are situations in which a student's in-person presence is crucial [24]. Blended learning offers an opportunity to enhance and apply the digital skills and infrastructure developed during the pandemic in the post-COVID period [2].

Drawing on estimations from regular school closures, such as summer vacations, some researchers have approximated educational deficits due to the potential influence of COVID-19 school closures on student education. According to Kuhfeld et al. [36], students who were not able to receive three months of distance instruction in the spring of 2020 would only have made 37% to 68% of their average mathematics and reading learning gains by the fall of 2020, and some would even be up to a year behind in math. It was predicted that even pupils who got remote teaching in the spring of 2020 would only have 60% to 87% of their usual learning gains by the time fall 2020 arrived. According to Namkung et al. [37], when comparing the 2020–2021 school year with previous years, teachers indicated that they were able to cover a significantly smaller portion of the intended curriculum in mathematics. The percentage of teachers who managed to cover 80% of the mathematics curriculum dropped from 92.8% in regular years to just 53.2%.

Studies have not been conducted, to the researcher's knowledge, to examine the feelings of students from the UAE about their experience of returning to normal life regarding education after COVID-19 has subsided. Therefore, research should be conducted to capture students' perceptions regarding their lived experience of face-to-face education after returning from distance education for better implementation in the future. In a study by Abidin et al. [38], learning motivations for online and in-person learning during and after the COVID-19 pandemic are compared. It has been discovered that when students resume in-person instruction, their motivation to study increases. Students are less motivated while learning online because they tend to play rather than pay attention to their lessons. Similarly, the COVID-19 pandemic has a substantial influence on students' psychological well-being, such as academic anxiety [39] and mental health difficulties that include loneliness and social isolation [40]. However, when schools reopened, preventive measures like mask-wearing, hand sanitization, and maintaining social distance caused classroom anxiety to rise even more, according to Rashid et al. [39].

Many students would prefer not to continue with online learning after the pandemic if given the option. Yet, they show their desire to continue using some of the benefits of online education. During the pandemic, many mathematical products, such as worksheets, videos, and PowerPoints, were developed to improve the students' learning. The study of Lusiana and Kesumawati [19] focused on the product quality and practicality of the mathematics learning resource and the potential impact on mathematics learning. It was found that the products developed were feasible to use to facilitate online and offline learning. Mathematics education after COVID-19 demonstrated less effective learning because of extended online learning, leading to students' reliance on the internet and lack of interest in mathematics [41].

As indicated in this literature review, there is insufficient research on education after the COVID-19 pandemic. So far, nothing has been found to study the UAE context. This research seeks to fill this gap in the literature, exploring students' lived experiences of transitioning to face-to-face education. This will provide us with a better understanding of how to assist our students and what policies are needed to address the pandemic's effects to maximize the benefits for their educational process.

### ***2-3-The Transformative Learning Theory***

The theory of transformative learning by Mezirow [42] suggests that learning happens when students encounter an expected or uncomfortable situation. Mezirow [42] believes that a disorienting issue generates modifications that result in cognitive disparities and profound educational changes. Mezirow [42] defined transformative learning as “an orientation which holds that the way learners interpret and reinterpret their sense experience is central to making meaning and hence learning” [43]. The context in which transformational learning is applied is one in which quick changes may be required to adapt to unforeseen circumstances or make a quick transition. This suggests that transformative learning occurs when students create meaning when interacting with their environment and make changes in their attitudes, behaviors, and understanding. According to this idea, students should be encouraged to think critically and logically to gauge how well they grasp the learning process as they encounter difficult problems during paradigm changes [44]. The COVID-19 pandemic has led to paradigm shifts and transformations when education suddenly shifted online, and likewise when it returned to face-to-face education when COVID-19 subsided. Therefore, this theory is relevant to the present study because it explores students' experiences with teaching and learning during a period of rapid transition in education.

## **3- Research Methodology**

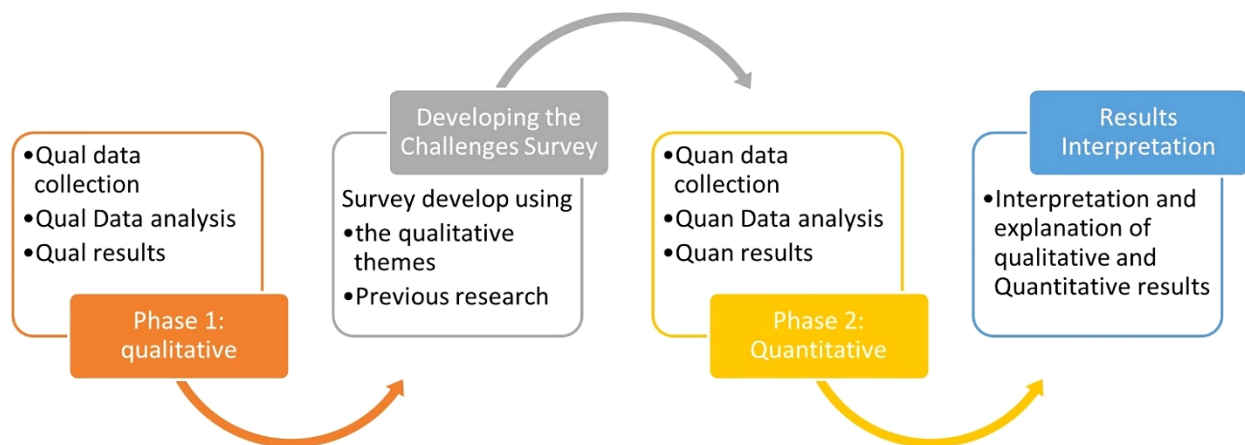
### ***3-1-The Context of the UAE***

This study focuses on one school in the UAE as a case study. The COVID-19 pandemic has impacted every nation on the planet, including the UAE. The UAE, which is well-known for its dedication to high-quality education, is actively attempting to lessen the pandemic's negative effects on student learning outcomes. Educators and policymakers have employed creative tactics to enable successful remote learning throughout the pandemic, such as the utilization of digital resources, online platforms, and video conferencing tools. These efforts have been instrumental in ensuring students' access to education during times of restricted physical interaction.

The UAE generally adopts the three-semester system during one academic year of school education. The COVID-19 pandemic forced a switch to distance learning, which began in March 2019 and lasted until the end of the third semester of that year. Distance education continued during the academic year 2020-2021 as well for a period of three full semesters until a gradual return to face-to-face learning began during the year 2021-2022, when hybrid learning was adopted for two semesters to consider security, safety, and physical distancing. Hybrid learning provides both face-to-face and distance learning at the same time, and this allows the infected students to continue their learning remotely. The application mechanism of hybrid learning included dividing classes with more than 20 students into two groups, A and B, where learning is face-to-face for group A and remote for group B for a week, and then exchange takes place in the following week. In classes of 20 students or less, all students are allowed to learn face-to-face, with the option of distance learning. In the third semester of the 2021-2022 academic year, all students returned to school, observing precautionary measures such as physical distancing and the permanent use of masks in enclosed spaces. The academic year 2022-2023 witnessed a full return to face-to-face learning.

### 3-2- Research Design

The present study employed an exploratory sequential mixed-method design that applied the Qual-Quan model. Mixed-methods research is defined by Tashakkori & Creswell [45] as "research in which the investigator collects and analyzes data, integrates the findings, and draws inferences using both qualitative and quantitative approaches". There are two main components to the design: a qualitative exploratory strand and a quantitative second strand [46]. Exploratory sequential mixed methods are a way of gathering and analyzing qualitative and quantitative data in a series of phases [47]. The authors collect qualitative data in the first phase, analyze it, and use the results to guide quantitative data collection for the next phase, which could include a survey or another type of quantitative data collection that greatly benefits from qualitative analysis to assess the trends of individuals across a larger sample. The current study employed a focus group interview in the qualitative phase, then used the collected data to create a self-designed survey to collect the quantitative data in the second phase of the study. The following flowchart explains the design of this study, as depicted in Figure 1:



**Figure 1. Flowchart of the research design**

The purpose of this research is to study the students' lived experience after COVID-19. Creswell [48] specified that "a phenomenological study describes the meaning for several individuals of their shared experiences of a concept or a phenomenon" (p. 57). Therefore, the phenomenological mixed technique was chosen for this purpose because it would enable individuals to talk about their actual experiences. Learning from the experiences of others is crucial in education. Educators rely, whether intentionally or unintentionally, on the experiences of others to build their profession and develop their practice. Neither quantitative nor qualitative approaches by themselves can adequately convey the substance and details of the current topic under investigation. This mixed design is also necessary since it enables the identification of variables from participant accounts, the creation of an instrument on its foundation, and the subsequent testing of the first collected data to determine their applicability to additional groups. Consequently, by offsetting the limitations of qualitative data with more empirically supported quantitative data, the combination of quantitative and qualitative data enhances the validity of conclusions [46].

### 3-3- Participants

There are three educational levels in the UAE: cycle 1, which covers grades 1-4; cycle 2, which covers grades 5-8; and cycle 3, which covers grades 9-12. Each student is required to study the same subjects until the eighth grade. Following that, students select either a general or an advanced strand. The sample selection technique for this study was the convenience sampling method. For the qualitative phase of the study, the researcher approached 11th-grade advanced

students, and 12 students participated in a focus group discussion. For the quantitative phase, the survey was available to 505 students from one female school who were invited to respond to an electronic survey. Participants who voluntarily responded to the survey were 243 students from cycles 2 and 3 (grades 5–12), which gives a response rate of about 48% of the school students. This survey was created especially for this research to learn more about how students feel about returning to in-person instruction after COVID-19. The participants in the quantitative part of this study were 54% from cycle 2 and 46% from cycle 3, as presented in Table 1.

**Table 1. The participants' distribution (n=243)**

Cycle	Grade	Frequency
Cycle 2	5	29
	6	40
	7	29
	8	43
Cycle 2 total and percentage		131 (54%)
Cycle 3	9 Advance	12
	9 General	20
	10 Advance	13
	10 General	21
	11 Advance	13
	11 General	20
	12 Advance	3
	12 General	9
Cycle 3 total and percentage		112 (46%)
Total (Cycle 2 & Cycle 3)		243 (100%)

### **3-4- Qualitative Research Instrument: Focus Group Discussion**

The first phase of this research is the qualitative part, which explores the participants' lived phenomena of experiencing returning to face-to-face education after COVID-19 decline cases. The instrument used in this phase of the study was the focus group discussion. Bradbury-Jones et al. [49] argue that focus groups are identical to phenomenological research. They go on to explain that group interviews in phenomenology are useful and preferable since they generate discussion and open up new ideas. A focus group is a research technique in which a small group of participants responds to questions in a controlled setting. The questions are intended to provide light on an interesting topic, and the group is selected based on predetermined demographic criteria. Focus groups enable the collection of information as well as the gathering of insights on its validity by analyzing replies across a group of participants, as the questions are presented to a group rather than an individual. Focus groups can be an effective strategy for gathering trustworthy and reliable information by promoting interaction among student participants [50]. Thus, focus groups are appropriate for this research objective since they can provide a better grasp of the topic under study.

The focus group interview questions were first piloted with three students to make sure they were clear. Their input was taken into consideration while modifying the wording of a few questions to improve the validity of the content. Ultimately, the interview questions were examined by a mathematics teacher too. These processes improve validity both inside and outside the system. Both the focused interview guide and questions are presented in Appendix I.

The researcher who facilitated the focus group discussion made an effort to maintain objectivity and refrain from answering questions while monitoring students' nonverbal cues, such as nodding and raising eyebrows, and considering the potential for observer bias. The researcher displayed active listening skills by repeating replies, seeking clarification, or asking students to provide examples. Furthermore, the researcher either directly asked the less-spoken students questions to encourage them to engage or addressed the participants by name to ensure that reaction times were consistent among participants.

When transferring the findings of a phenomenological investigation, care must be taken to avoid misinterpretation or misunderstanding. Three investigators independently transcribed the audio recordings, coded the data, identified themes using an inductive technique, and classified the findings. The three investigators independently conducted thematic analyses to arrive at a final consensus on themes. To assess the account's authenticity and accuracy, the participants were asked to read and verify their responses. The reliability of the data was confirmed by comparing the responses of the participants. The validity of the conclusions was ensured by multiple codings, an audit trail, and member checking with focus group participants who evaluated the themes [50].

### 3-5-Quantitative Research Instrument: The Challenges Survey

This survey was designed and developed by the author specifically for this study to gather more information about students' perceptions of the challenges they encounter after transitioning back to face-to-face learning. Three investigators contributed to the validity of the content of the survey. Three items were paraphrased, and one item was deleted from the survey. The purpose of this survey was to give students a voice to discuss their personal experiences as well as to emphasize and elucidate their ideas. The survey begins by asking the students to specify their grades. The next section involved using ten items on a 5-point Likert scale to evaluate the presented challenges. Finally, students were asked to select their preferred mood for learning. The reliability of the challenge survey was determined following the collection and analysis of student perception data. Cronbach's alpha, the most commonly used measure of scale reliability, was utilized to calculate reliability and was determined to be 0.71. According to George and Mallery [51], a Cronbach's alpha value of 0.70 is considered acceptable. This has also been supported by other studies, with the acceptable range for alpha being 0.70 to 0.95 [52].

## 4- Results and Discussion

For the qualitative analysis, thematic content analysis was employed to identify emergent themes [53]. The data's similar patterns were found, grouped, and eventually assigned to distinct themes. The researcher conducted the process independently, and it was then repeated by three investigators to enhance the result's credibility. The challenge survey was analyzed after being distributed to all participants. The descriptive analysis was used to analyze the quantitative part of the survey. In addition, the independent t-test was applied to compare students' perspectives in cycles 2 and 3.

### 4-1-The Qualitative Part-Focused Group Discussion

The 12 students in the focus group were asked about their experience with transitioning back to face-to-face learning after COVID-19 had ended. The results showed 6 themes that presented the students' contradictory thoughts were about: "General adjustment effort", "Learning and studying habits", "Teaching and technology", and "Assessment methods and feedback".

- **General Adjustment Effort**

Students show contradictory views about the adjustment efforts needed when transitioning back to face-to-face learning. They also have different rates for their efforts. Some students find it very difficult and pointless to be in school every day. Student 2 said, "It's difficult to wake up early again for school. Long school day, but a lot of wasted time." Student 4 explained, "I am wasting a lot of time at school. Traveling to school is taking time; time is also wasted between periods." Student 3 added, "I don't feel safe while interacting with other students and teachers. I am still afraid of COVID-19". However, student 7 had another opinion in this regard, saying, "Being at school is a blessing; I can wake up on time, and I feel it is worthy to wake up and start my day". But student 8 raised another issue of getting bored from her perspective of being in face-to-face learning "I feel bored more than before when I learn mathematics. I can't sit disciplined for a long time.". Student 1 added, "I can't sit in the class for a long time; online learning is more flexible.". This is incongruent with Kusmaryono et al. [5], who noted that many students choose to learn remotely so that they do not have to leave their homes. Students can learn without being limited by time or place.

Some students complained about the long screen time, student 12 stated "I thought that screen time would be less than in distance learning, but I was wrong. We still use laptops in class, and we need to do more tasks at home." Students 2, 3, 4, and 5 nodded their heads in agreement, while student 9 added, "We can't even finish the lesson at Alef Platform in class every day, and we need to finish it at home" Student 3 added, "Additionally, we need to work on our projects too. This is boring and puts more pressure on us."

It can be concluded from previous students' comments that most students are having difficulty adapting to face-to-face education again, although they welcome their return to schools, but there is no full agreement.

- **Learning and Studying Habits**

This theme reflects the impact of distance learning on students' learning experiences, which overshadowed their return to school seats to receive their lessons in person. Most of the students' complaints were about the weakness of their current studying skills. Student 11 stated, "I don't take notes like I did before COVID-19; I usually ask my teachers to save notes and then send them to us" Likewise, Student 1 added that she even forgot how to study mathematics "I forget how to study math; I don't practice writing the steps to solve mathematical problems, I only read the solution steps.". Student 2 added, "Honestly, I lost my study skills after the online learning". Student 5 added that she faces another problem as she didn't used to write in the previous two years "My teacher can't understand what I'm writing. I'm trying to improve my handwriting because it's worse than it was before COVID-19 as I was just typing on the computer". A study conducted by Quinn and Aarão [34] found that students learning online may lack the skills to effectively self-regulate their learning. This was confirmed by Student 1 comments, where she tends to delay studying the difficult mathematics problems that require high-order thinking skills to skip them at the end because they will most

likely not be included in the test. Student 7 explained, *"I don't trust myself while solving mathematical problems by showing the steps"*. Additionally, Student 3 said, *"I always feel like I missed something that was previously taught during the COVID-19 lockdown."* Student 9 confirmed, *"My lack of mastery of previous math concepts at the time of Corona affects my understanding of the current lessons"*. Student 12 shows that this affected his confidence by saying *"I feel hesitated to ask for clarification; I have the feeling that I don't understand the lessons because I missed the prerequisites during Corona time"*.

Learning that is not applied correctly will delay the learning process, a phenomenon known as learning loss [54]. As such, one of the causes of learning loss is the COVID-19 pandemic. Many researchers reported that students faced learning deficits during the pandemic [55]. Learning loss is a situation in which students encounter a decline in the time they spend learning and a lack of motivation to learn [56]. Students are less motivated to learn online because they choose to play instead of paying attention to their studies. However, it has been shown that when students resume face-to-face learning, their motivation to study grows [38]. This suggests that students may put in more effort and spend more time studying because they are now more motivated when they learn face-to-face.

Moreover, Students 10, 3, 4, and 5 raised another issue that students deal with when they study, as they are preparing themselves to solve exam problems. Student 10 summarized the problem, saying, *"Instead of studying to solve problems by steps, I used to get the answer in the math exams by checking the multiple-choice alternatives only."* Additionally, student 1 said that *she tends to delay studying the difficult mathematics problems that require high-order thinking skills to skip them at the end because they will most likely not be included in the test*. Furthermore, student 3 shed light on an important issue in this regard, which is using websites to get answers without understanding, she said: *"During Corona, I learned to use many websites like "Mathway" to help me find the answer to the math problems. At that time, I only cared about the final answer. However, now my teacher asks me to show my steps"*. Student 2 added, *"I feel Math now is more complicated than Corona time, my teacher keeps showing complicated steps"*. Quinn and Aarão [34] explained that online learning provides some flexibility, which also provides students with flexibility that may lead students to abuse it by avoiding mathematical study. However, there is a portion of students who benefited from the platforms that were used during the pandemic, as stated by student 1, *"I use Mathway just to check my answer"*, this makes her more confident in her solution and reduces her study time. The remaining 8 students supported her point of view. Likewise, Student 8 was positive about the face-to-face learning, stating that *"Studying time now is less because I understand more when being in class."* In the same vein, student 2 explained that being in class allows them to easily ask their teacher or their colleagues about unclear points and get clarification instantly. Student 7 agreed, *"I learn easier now because my teacher or my colleagues can explain the ideas easily for me."* Students 6, 9, and 11 agreed with student 7.

This emerging theme has overshadowed students' return to face-to-face learning after the pandemic subsides. This indicates that students' distance learning has fundamentally affected their study habits.

- **Teaching and Technology**

Teachers' teaching methods have been affected by the COVID-19 era, as per students. Unsurprisingly, some students' perspectives revealed a positive impact, while others showed the opposite. For example, student 8 indicated the positive impact of using interactive platforms to explain mathematics lessons by saying *"Despite the fact that my math teacher always uses interactive platforms like Desmos or Geogebra but after COVID-19 she is using them more effectively."* Student 12 added, *"I like that my teacher is using Geogebra to clarify the geometry for us, this shortens the explanation time and is more effective and clearer than a lot of words."* The rest of the students supported this perspective. This is consistent with the work of Jamilah and Fahyuni [2], which suggests that software packages can have a positive impact on learning.

On the other hand, students complained about the excessive use of platforms during mathematics lessons. For example, Student 9 expressed his feeling of being distracted *"Using many platforms is distracting me; for example, using Alef, Word Wall at the same period, I feel that there is no need to do the easy questions many times"*. Student 4 confirmed, *"Yes, this is really distracting"*. Likewise, Student 6 added, *"I don't like the idea of using the laptop at any time in the class"*. In this regard, students also criticized the excessive use of technology in presenting the lesson at the expense of meaningful explanations. Student 6 declared that *"The teacher is focusing on using many platforms instead of spending more time in explaining the material for us"*. Student 5 extended *"Using technology is overwhelming, they focus more on showing rather than building students' understanding"*. The students' notes were in line with Basitere et al. [7], where they consider that the stress on the familiarization with new technologies was the reason behind the delay in learning mathematical knowledge. Only students 8 and 10 supported this feeling, while students 9, 11, and 12 defended the teacher, who explained that they understood that the teacher attempted to reduce the learning loss in this way. In addition, Student 1 said that *"The teacher is required to employ technology in the classroom and is evaluated accordingly by the administration"*.

Furthermore, the results of the current study revealed that students felt the curriculum remained unchanged despite the COVID-19 closure. Similarly, Teachers reported covering less of the intended math curriculum, providing fewer necessary interventions to students, and seeing fewer students ready to move to the next grade level during the 2020-2021 school year compared to regular years [37].



### • Assessment and Feedback Methods

Students also elaborated on “Assessment and feedback methods”. Student 6 reported that she was not confident when solving mathematical problems by steps, she said: *“I am not able to solve a mathematical problem with multiple steps on my own. I don't trust my solution.”* Students 1, 2, 9, and 10 supported the same claim. Student 3 explained, emphasizing her feelings of math test anxiety *“I feel anxious about math exams more than before”* This is consistent with the findings of Doz & Doz [17], who indicated that students with a high level of mathematics anxiety showed significantly lower levels during distance learning. Student 4 explained that *“During Corona, all the questions were easy in the final exam, and if I faced any difficult question, I would ask my friends or even anyone in my family to help me; in other words, I would cheat the answer, but I can't do that now in face-to-face sitting”*. Student 2 confirmed *“Honestly, when we encounter difficulty in solving any mathematical problem, we feel helpless and immediately attribute the reason to distance learning, as we all lost some lessons during distance learning, which made us feel that we lost part of the knowledge required for the solution.”*

However, student 8 was happy to receive *“instant grade just after any online quiz”*, but on the other hand, student 5 complained that *“feedback on paper exams may take days as the teacher needs more time now to mark our paper exams”*. Moreover, some students were very honest when they described their false feelings about their excellent performance during the distance learning where student 3 declared that *“Last year, I've got an A but honestly I am not an A student”* but this was rejected by student 8, who said that *“I used to be an A student, and the distance learning didn't affect me at all”*. Additionally, Student 5 added *“doing online exams is less stress than paper exams.”* The rest of the 9 students nod their heads in agreement.

The results of Rashid et al. [39] showed that a significant number of students reported feeling anxious and stressed due to the impact of COVID-19. This had negative effects on their comfort level on campus, their class participation, their social interactions, and their overall university experience. This supports the current study results, where 50% of the students reported that they experienced more anxiety about mathematics than before COVID-19. This might be supported by another challenge of the students feeling that they missed something that was taught previously during the COVID-19 lockdown. This might also explain why students prefer to continue with the flexible online assessment that agrees with other research [25].

From the previous four themes, students showed controversial perspectives with no agreement. To understand these perspectives, Table 2 presents the percentages of challenges and opportunities for each theme.

**Table 2. Frequencies and percentages of students' comments**

No.	Theme	Students' comments' frequency (%)		Total (Percentage)
		Opportunities	Challenges	
1	General adjustment efforts	5(38%)	8(62%)	13 (17%)
2	Learning and studying habits	11(42%)	15(58%)	26 (35%)
3	Teaching and technology	6 (40%)	9(60%)	15 (20%)
4	Assessment and Feedback Methods	10(48%)	11(52%)	21 (28%)
<b>Total (Percentage)</b>		<b>32(43%)</b>	<b>43(57%)</b>	<b>75 (100%)</b>

In general, Table 2 shows that about 43% of students' opinions regarding the face-to-face learning experience after distance learning reveal opportunities, compared to 57% about challenges. The highest percentage of student comments was 35% for the "Learning and studying habits" theme, with 58% of these comments, reflecting challenges such as poor study skills. The second highest percentage of student comments was 28% for the "Assessment and Feedback Methods" theme. Likewise, 58% of students focused on challenges, such as math exam anxiety, more than opportunities. The third highest percentage was 20% for "teaching and technology", where 60% of students reported that they faced challenges such as excessive use of technology by teachers and incorrect use by students. The "General adjustment efforts" theme had the lowest percentage, 17%, but like the rest of the previous themes, it reflected more challenges than opportunities.

Participants were asked for suggestions for improving the implementation of face-to-face learning in the future. They reported adding some aspects of online learning to face-to-face learning and removing others. The students' suggestions are presented in Table 3.

**Table 3. Suggestions for future implementation**

Themes	N (%)	Examples of students' comments
Keep from distance learning	19 (66%)	“I would like to continue taking online classes to review before the exam.” S3
		“Despite that, I prefer the specific feedback of my teacher about my performance directly, but I wish to continue with the online exams as we receive grades instantly.” S8
		“I like that my teacher is using Geogebra to clarify the geometry for us, this shortens the explanation time and is more effective and clearer than a lot of words.” S6
Remove from distance learning	10 (33%)	“Platforms such as Quizzez or Padlet are often used to assess only basic knowledge. I hope this can be reduced as it will not increase my understanding.” S9
		“Many teachers communicate with students for classroom work using social media, it's distracting, I suggest putting more restrictions. S5

Table 3 shows that students' suggestions were under two categories, where they mentioned some features of distance learning that they preferred to keep and others to remove. Student 7 highlighted the benefit of using online meetings, saying "When we study at home for our final exam, sometimes we have some questions to ask, so our teacher used to make time to meet us in Microsoft Teams to answer them. This helps and saves time." Student 5 added, "That's true; sometimes all we need is a hint of an idea from the teacher to continue because we have already studied the material." Student 3 said, "I would like to continue taking online classes to review before the exam; this is time-saving." All the students show agreement with Student 3.

Regarding the teaching methods, all the students show similar agreement on the benefit of using interactive technology in class such as Geogebra for example student 6 said "I like that my teacher is using Geogebra to clarify the geometry for us, this shortens the explanation time and is more effective and clearer than a lot of words." Students 11 and 12 also agree. Additionally, regarding the assessment and feedback, Student 8 explained "Despite that paper exams are important to emphasize writing the steps when solving problems, but to continue with the electronic exams as we receive grades instantly" Student 9 said, "It would be better to have a balance between the paper exam and the electronic exam because, with the paper exam, I receive more specific feedback from my teachers about my performance".

On another hand, student 9 highlighted the overuse of "Platforms such as Quizzes or Padlet, which are often used to assess basic knowledge only. I hope this can be reduced as it will not increase my understanding." Student 3 confirmed "It's just a waste of time" All the students agreed. Additionally, student 5 talked about communication using social media "Many teachers communicate with students for classroom work using social media; it's distracting. I suggest putting more restrictions" Student 4 said, "I agree; some teachers send us messages to do something at 11 p.m.; this puts more pressure on us". There is a group of students who feel that everything is fine with distance learning, but they prefer more interaction as mentioned by student 6 "I consider myself as one of the excellent students in mathematics. Honestly, I don't feel that distance learning is different than face-to-face learning for me; I only missed the interaction with my colleagues." Students 2, 8, 10, and 11 confirmed the importance of interaction with other students and teachers, especially in mathematics. Student 7 said, "My colleague who is sitting beside me explains many math problems for me easily".

As a result, the students prefer adjusted face-to-face learning, where 66% showed a preference for keeping some distance learning features compared to 33% asking to discard others.

#### 4-2-The Quantitative Part: The Challenges Survey

The challenges survey that was developed using the emergent themes from the focus group was distributed among all students from grade 5 to grade 12. The purpose of this survey is to learn about the students' perceptions, specifically of the presented challenges. Therefore, descriptive statistical analyses were employed for the 10 items (challenges) of the 5-point Likert scale statements of the challenges survey by calculating the frequencies, mean scores, and standard deviation of students' responses as presented in Table 4.

**Table 4. Perceptions Survey Descriptive Analysis (Frequencies, means, and standard deviation)**

#	Survey Items (Challenges)	SD	D	N	A	SA	M	SD
1	I always feel like I missed something that was previously taught during the COVID-19 lockdown."	39	25	70	50	59	3.27	1.363
2	The curriculum is the same and did not consider the gap due to the time of Corona	59	29	60	43	52	3.00	1.46
3	I use technology to find the final answers to math problems rather than solve them myself	55	75	47	30	36	2.66	1.349
4	I am more anxious about math exams than during the COVID-19 time.	24	24	72	64	59	3.45	1.237
5	It's difficult to go back to write the problem solution in steps after only selecting the answer for multiple-choice problems.	26	21	68	40	88	3.59	1.337
6	The teacher emphasizes more on the use of technology in class rather than the mathematical concept	65	48	57	36	37	2.72	1.398
7	I lost my study skills after the online learning	12	15	39	72	105	4.00	1.135
8	We spend long screen time, we still use laptops in class, and later do more tasks at home	24	34	38	43	104	3.70	1.396
9	Using many platforms regularly is exhausting and time-consuming.	75	34	46	48	40	2.77	1.479
10	Teachers' heavy reliance on social media to communicate with students about assignments any time after school leads to distraction	58	41	51	57	36	2.88	1.395
Full Survey							3.2	0.715

Table 4 shows that the full survey mean was 3.20. It could be noticed that the mean of the items ranges between 2.66 to 4. It could be noticed that the mean of all the items and the full survey mean were all above 2.5. This indicated general agreement on the challenges.

However, the frequencies showed that a large number of students held natural responses to each item of the survey. This makes it hard to realize the actual percentage of agreement. Therefore, the percentages of the two responses (A and SA) that reflect agreement were calculated as presented in Table 5.

**Table 5. The Total Percentage of Agreement and Strong Agreement**

#	Survey Items (Challenges)	A%	SA%	Total%
1	I always feel like I missed something that was previously taught during the COVID-19 lockdown.”	20.6	24.3	44.9
2	The curriculum is the same and did not consider the gap due to the time of Corona	17.7	21.4	39.1
3	I use technology to find the final answers to math problems rather than solve them myself	12.3	14.8	27.2
4	I am more anxious about math exams than during the COVID-19 time.	26.3	24.3	50.6
5	It's difficult to go back to write the problem solution in steps after only selecting the answer for multiple-choice problems.	16.5	36.2	52.7
6	The teacher emphasizes more on the use of technology in class rather than the mathematical concept	14.8	15.2	30.0
7	I lost my study skills after the online learning	29.6	43.2	72.8
8	We spend long screen time, we still use laptops in class, and later do more tasks at home	17.7	42.8	60.5
9	Using many platforms regularly is exhausting and time-consuming.	19.8	16.5	36.2
10	Teachers' heavy reliance on social media to communicate with students about assignments any time after school leads to distraction.	23.5	14.8	38.3

Table 5 reveals the percentage of agreement on the challenges. The results showed that 45.2% of the students agreed or strongly agreed with the listed challenges. The highest percentage of agreement was 72.8% (item 7) for the students' feeling of losing their study skills, as indicated by item 7 of the survey. Followed by 60.5% (item 8) of the students who spend long screen time. The third highest percentage was 50.6% (item 5) of students feeling more anxious about math exams than during COVID-19.

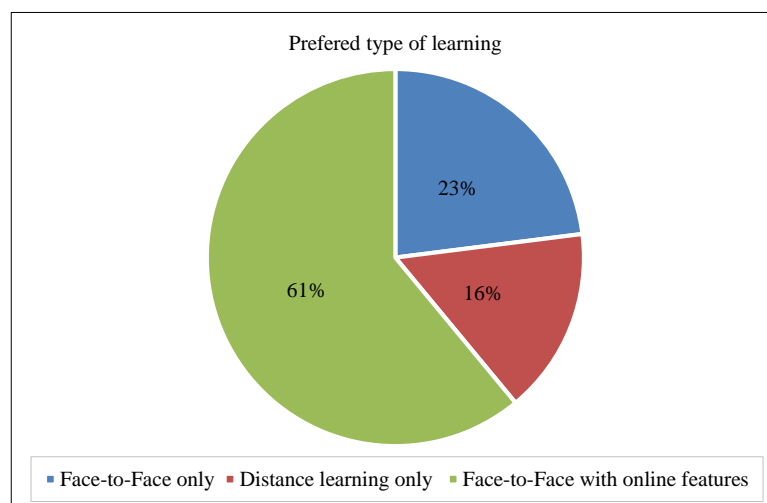
On the other hand, the percentage with the lowest agreement was 27.2% (item 3) of students using technology for the sake of learning rather than getting the final answer. Then 30% (item 6) of the students see that teachers use technology in the classroom rather than emphasizing the mathematical concepts. While 36.2% (item 9) of the students agree that using many platforms is exhausting for them. The results of Table 6 are per the results of Table 5, which means that the neutral responses of the students didn't affect the general agreement of the students.

Furthermore, an independent-sample t-test was performed to compare the cycle 2 and cycle 3 students' perceptions of the challenges of face-to-face learning after distance learning. Equal variances were assumed for homogeneity of variance based on Levene's test of equality of variances ( $F = 3.333$ ,  $P = 0.069$ ). The results of the independent t-test are presented in the following Table 6.

**Table 6. Comparison of Cycle 2 and Cycle 3 Perceptions of Challenges**

Variable	Cycle2 (N = 131)		Cycle3 (N =112)		T	df	P
	M	SD	M	SD			
Challenges perceptions	3.23	0.75	3.17	0.68	0.632	241	0.528

Table 6 indicates no statistically significant difference between cycle 2 ( $M = 3.23$ ,  $SD = 0.75$ ) and cycle 3 students ( $M = 3.17$ ,  $SD = 0.68$ ) in their perceptions of the challenges ( $df = 241$ ,  $t = 0.632$ ,  $p > 0.05$ ). The researchers failed to reject the null hypothesis. This suggests that students in cycles 2 and 3 have mostly similar opinions regarding the challenges that are being faced. Finally, when students were asked to select their preferred type of learning, the percentage of students who selected face-to-face learning with some features of distance learning was 61%, while 23% selected face-to-face learning only and 16% selected distance learning only. The results are presented in Figure 2.

**Figure 2. Preferred type of learning**

Many studies indicate that online education is not as effective as face-to-face learning [57]. In general, the results of this study align with most of the literature reviewed. Students believe that face-to-face learning is more effective and efficient, but they also advocate blended learning as a good alternative [10]. Finally, the results of the qualitative and quantitative analysis revealed agreement on the major challenges that face students when they return to face-to-face learning after the pandemic collapse. On top of these challenges are students' lack of study skills, excessive use of technology, and high levels of math test anxiety. This indicates the need to pay special attention to training students in effective self-regulation strategies. This could contribute to reducing math anxiety, another challenge facing students. Therefore, moving forward with further adjustments for a new educational future is necessary to mitigate the COVID-19 pandemic's impact. As a result, this blended learning environment may be viewed by important stakeholders as a sustainable form of education in the future [58].

## **5- Conclusion**

The global COVID-19 pandemic has had a significant influence on education, requiring the use of online learning strategies by schools to ensure educational continuity. This change brought with it a new set of challenges for teachers, students, and schools, but it also presented an opportunity to investigate the effectiveness of distance learning and learn more about how students view this new way of teaching and what they can retain for better learning.

The qualitative results of this study revealed no consensus of the students' perspectives as more challenges were presented compared to opportunities. Therefore, challenges were summarized from the students' comments to be studied quantitatively. The results of qualitative and quantitative analysis revealed agreement on major challenges.

Among these challenges is the students' study skills where students reported that they lost their study skills after the distance learning experience. Such as the skill of writing the mathematical problem solutions in steps.

Most of the students conveyed their preference for face-to-face learning but with some features of online learning. To this end, students suggested keeping several aspects of online learning to their new face-to-face education. The flexibility of having revision classes before their exams was on top of these suggestions. In contrast, the students do not wish to continue with the pressure of having several platforms and technological tools. The students provided practical suggestions that, in their view, could lead to a balance between face-to-face and online education.

### ***5-1-Implications and Future Research***

The global pandemic altered the educational landscape, and online learning is now a vital element of the educational system. As a result, and based on students' experiences, policymakers are advised to incorporate parts of online learning reported by students into traditional face-to-face learning for a better experience. For example, changes could be made to keep the online assessment that presents flexibility [25]. This flexibility might be the reason behind having reduced Mathematics anxiety.

Even though COVID-19 has passed, digital literacy must be maintained because it is critical in preparing students for the future. As such, integrating more technological aspects into the mathematics curriculum would help the students to understand it in a better way. In addition, a serious review of the curriculum should be undertaken to ensure that it bridges the gap due to distance learning. This may contribute to a greater understanding and may reduce students' feelings of missing important information.

### ***5-2-Limitations***

This study focused on a single female school with two levels of education. To validate our results, a more comprehensive analysis of a larger sample would be required. Extending this case study to include male students at the district level would also be beneficial. The viewpoints of administrators and teachers deserve to be given greater attention.

## **6- Declarations**

### ***6-1-Data Availability Statement***

The data presented in this study are available on request from the corresponding author.

### ***6-2-Funding***

The author received no financial support for the research, authorship, and/or publication of this article.

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**6-4-Institutional Review Board Statement**

Not applicable.

**6-5-Informed Consent Statement**

Informed consent was obtained from all participants involved in the study.

**6-6-Conflicts of Interest**

The author declares that there is no conflict of interests regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely observed by the author.

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## **Appendix I**

### ***Interview Guide:***

Thank you for accepting to join this focus group interview. This interview is intended to find out about your experiences learning mathematics in person after the effects of Coronavirus (COVID-19) have subsided. We want to understand what your experience is like with face-to-face learning after two years of online learning. Participation in this interview is completely voluntary. If you wish to stop the interview at any time, please let us know. Feel free to jump in to add any comment to agree or disagree with any presented opinion. There will be a 20-30 minute interview.

### ***Questions:***

- How do you describe the return to face-to-face after Corona?
- How do you describe your efforts in coping with face-to-face learning after Corona?
- How do you describe your learning mathematics in the face-to-face time?
- How do you describe your teacher's method of teaching?
- What do you think of assessment in face-to-face time?
- What should be kept or removed from your experience for future learning experiences?