*International Journal of Learning, Teaching and Educational Research*
*Vol. 21, No. 1, pp. 179-194, January 2022*
*https://doi.org/10.26803/ijlter.21.1.11*
*Received Sep 30, 2021; Revised Dec 31, 2021; Accepted Jan 19, 2022*

# Mathematics Learners' Perceptions of Emergency Remote Teaching and Learning during the COVID-19 Lockdown in a Disadvantaged Context

**Brantina Chirinda, Mdutshekelwa Ndlovu and Erica Spangenberg**
University of Johannesburg, Johannesburg, South Africa

**Abstract.** The COVID-19 global pandemic's impact on education will take years to resolve. At this point, it is sensible to ponder the big questions of mathematics teaching and learning in disadvantaged contexts. This descriptive mixed-methods study is focused on the learners' perceptions of the Emergency Remote Teaching and Learning (ERTL) of mathematics during the COVID-19 lockdown. The study was conducted with 137 learners at public secondary schools in a disadvantaged context in South Africa. Purposive and stratified random sampling techniques were used to select the respondents. The data was collected through a Google-generated semi-structured questionnaire. Content analysis was used to analyse the qualitative data from the open-response items. The quantitative data was analysed using the Statistical Package for the Social Sciences. The findings were that most learners in resource-constrained contexts neither enjoyed nor benefitted from the ERTL of mathematics and preferred face-to-face classroom interactions with the teachers. Many learners stated that they were used to seeing the teachers' gestures, body language, and facial expressions. Most learners indicated that it was challenging not to work in groups when solving mathematics problems and that they could not learn mathematics productively at home. Further findings were that the COVID-19 pandemic has negatively impacted learners in disadvantaged contexts since they did not have adequate digital resources and internet connectivity to learn mathematics remotely. The COVID-19 pandemic will end one day. Studying the learners' perceptions of the ERTL assists in the creation of programmes that can enhance digital mathematics teaching and learning in disadvantaged contexts.

**Keywords:** COVID-19 pandemic; digital transformation; disadvantaged contexts; emergency remote teaching and learning of mathematics; mathematics learners' perceptions

## 1. Introduction

This study focused on the learners' perceptions of the Emergency Remote

Teaching and Learning (ERTL) of mathematics during the COVID-19 lockdown. Before the outbreak of the COVID-19 pandemic, mathematics has been taught face-to-face in most countries around the world. Learners physically met their teachers in the classrooms and explored mathematical concepts. Learners grappled with mathematical problems as individuals, in pairs or in groups, and shared their thinking and understanding. Mathematics classrooms were an environment where teachers interpreted the learners' written work, analysed their reasoning, and responded to their solutions and solution strategies (Kilpatrick et al., 2001). Teachers around the world used both digital and non-digital resources to help learners do mathematics. To develop the learners' solid conceptual understanding of mathematics, teachers used several pedagogical strategies such as inquiry-oriented teaching, mathematical problem-solving, differentiated teaching, and cooperative learning. Teachers also engaged in physical manipulatives so then the learners could have hands-on experience with mathematics (Ball & Bass, 2003). Nevertheless, mathematics teaching and learning suddenly changed in March 2020 when the reports about the novel coronavirus started to captivate the attention of everyone around the world. Most countries declared a state of emergency and ordered the closing of schools (Chirinda et al., 2021).

The coronavirus, also known as COVID-19, is an infectious disease caused by the SARS-CoV-2 virus. Governments worldwide took various steps to extenuate COVID-19's spread, including social distancing. Social distancing meant the cancellation of public events and educational activities. Many institutions worldwide cancelled educational activities that included face-to-face classes, requiring learners to learn remotely from home (Basilaia & Kvavadze, 2020). By the end of March 2020, close to 90% of global learners were affected by the school closures (UNESCO, 2020). School closures were necessary despite disrupting the learning process because the previous studies on influenza pandemics have shown that this reduces the transmission of the virus (Cauchemez et al., 2009; Earn, 2012). Within South Africa, it was no different as the country entered nationwide lockdown on 27th March 2020 to lessen the transmission of the COVID-19 virus (Chirinda et al., 2021). During the COVID-19 lockdown, South Africa (like other countries) implemented a form of mathematics teaching and learning called ERTL (Hodges et al., 2020).

ERTL, which is different from well-thought-out online learning, was termed Emergency Remote Teaching by Hodges et al. (2020). Hodges et al. (2020) explained that ERTL is a temporary shift from face-to-face, blended or hybrid instruction to remote teaching due to a crisis or unexpected and sudden circumstances. ERTL is conducted to provide learners with temporary access to educational activities. South African Grade 12 mathematics teachers conducted ERTL during the COVID-19 lockdown (Chirinda et al., 2021). Mathematics concepts are ideally developed and conceptualised aptly in face-to-face teaching environments (Khirwadkar et al., 2020). The authors believe that ERTL impacts mathematics learning since the learners cannot experience the same interactive environments as they do in face-to-face learning. Accordingly, the authors were interested in learners' perceptions of the ERTL of mathematics in a disadvantaged context.

The investigation of learners' perceptions is crucial because even if the COVID-19 pandemic comes to an end, we need to know the factors that need to be considered for effective digital mathematics teaching and learning. Additionally, knowing the learners' perceptions helps us learn about the challenges and opportunities experienced by learners during the ERTL of mathematics to prepare for such crises in the future. Several studies have focused on ERTL during the COVID-19 pandemic (Dube, 2020; Basilaia & Kvavadze, 2020; Busto et al., 2021; Chirinda et al., 2021; Mhlanga & Moloi, 2020; Murat & Bonacini, 2020). Dube (2020) focused on rural online learning in the context of COVID-19 in South Africa. Basilaia and Kvavadze (2020) looked into the transition to online education during the COVID-19 pandemic at a private school in Georgia. Busto et al. (2021) studied blended mathematics teaching for engineering students during the COVID-19 pandemic in Italy. Chirinda et al. (2021) examined mathematics teaching during the COVID-19 lockdown in a poorly resourced context in South Africa. Mhlanga and Moloi (2020) explored COVID-19 and the Digital Transformation of Education in South Africa. Murat and Bonacini (2020) investigated the COVID-19 pandemic and remote learning in European countries. Nonetheless, not much is known about the learners' perceptions of the ERTL of mathematics during the COVID-19 pandemic in disadvantaged contexts. This study investigated learner perceptions of the ERTL of mathematics during the COVID-19 pandemic in a disadvantaged context in South Africa, thereby filling the identified gap in the mathematics education research literature. Disadvantaged contexts refer to geographical locations where people with low or no income live. Schools located in these contexts are usually resource constrained. This study unearthed essential aspects that must be considered when implementing digital learning platforms in disadvantaged contexts. As a result, this study adds to the mathematics education body of knowledge by providing insights into the perceptions of Grade 12 learners who have experienced the ERTL of mathematics for close to 10 weeks in a disadvantaged context. Accordingly, the research question investigated within this study was "What are the learners' perceptions of the ERTL of mathematics during the COVID-19 lockdown in a disadvantaged context?"

## 2. Study Aims

Firstly, this study aimed to explore the learners' perceptions of ERTL during the lockdown due to the COVID-19 pandemic. Secondly, the study envisaged investigating the obstacles and opportunities that the learners in disadvantaged contexts experienced during the ERTL of mathematics. Thirdly, the study's focus was to inform mathematics teachers, departments of education, mathematics education practitioners, and policymakers on the impact of the ERTL on learners and how mathematics teaching and learning in disadvantaged contexts can be best supported during the current COVID-19 and future pandemics.

## 3. Literature Review

The COVID-19 pandemic brought about unprecedented school closures to South Africa and worldwide. The ERLT of mathematics was conducted to offer some form of learning to learners whilst still observing social distancing. This form of teaching and learning was a new teaching strategy that had not been previously used to teach mathematics in South Africa. This study investigated the learners'

perceptions of ERTL of mathematics in a disadvantaged context in South Africa.

Before 1994, South Africa experienced a system of apartheid that discriminated against the non-white population. Since the apartheid, the South African government has attempted to redress the legacy of apartheid. Despite 25 years of post-apartheid political redress, inequalities remain remarkably persistent in South Africa (Statistics South Africa, 2019). South Africa continues to be one of the countries in the world that is deeply entrenched in social, economic, and educational inequalities (Statistics South Africa 2019), and it "has one of the unequal school systems in the world" (Amnesty International, 2020, p.7).

Because of its history, South Africa has two education systems (Spaull, 2019). The first school system, which serves the privileged minority, has well-resourced and fully functioning schools. The second system, which serves the disadvantaged majority, has under-resourced and generally dysfunctional schools. Schools that belong to the second system are in underprivileged contexts. The learners and their families live in relative poverty in a country where resources are inequitably distributed with one of the highest inequality rates globally (Amnesty International, 2020). This study focused on the learners who belong to the second school system who have limited access to digital resources.

Zoom, YouTube, Facebook live, MS Teams, and WhatsApp messaging were the top online platforms available for South African mathematics teachers to use to deliver lessons during ERTL. Nevertheless, in the context of this study, the learners neither had enough data nor adequate connectivity to attend synchronous online classes or to stream audio/video recorded lessons on these platforms, such that their teachers settled for the WhatsApp platform to keep the learning process going (Chirinda et al., 2021). WhatsApp is a free smartphone application platform that functions on most devices and operating systems. WhatsApp users can exchange text messages, images, voice notes, video files, and links to web addresses. WhatsApp as social media allows individuals to communicate with anyone who has the application, a smartphone, and an active internet connection. Its features include unlimited messaging, closed group chats, offline messaging, and no charges are involved since it uses the same data used by other applications on the smartphone. The WhatsApp platform can be discerned as a social system that allows learners to access information swiftly (Bouhnik & Deshen, 2014). The secure group chat allowed the teachers in the study context to provide a safe learning platform. Initially, the teachers generated videos, audio lessons, and pdf documents with problems or assignments and sent them to the learner groups that they had created. In this context, most learners could open the WhatsApp messages but did not have adequate data to download the resources (Chirinda et al., 2021). This led the teachers to use WhatsApp text messages to deliver the lessons.

Several studies have found that the WhatsApp platform improves interaction and collaboration, fosters dialogue, and promotes the sharing of knowledge among high school learners (Bouhnik & Deshen, 2014; Hrastinski et al., 2014; Lu & Churchill, 2014). Nevertheless, the COVID pandemic is unprecedented such that

the teachers and learners in the study were not genuinely prepared for teaching and learning through the WhatsApp platform. The pandemic's impact on education will take years to resolve. At this point, it is sensible to ponder on the big questions of mathematics teaching and learning in disadvantaged contexts. Accordingly, this study investigated the learners in disadvantaged contexts' perceptions of the ERTL of mathematics during the COVID-19 lockdown.

## 4. Theoretical Framework

This study conceptualised the WhatsApp platform as Virtual Communities of Inquiry. Accordingly, Communities of Inquiry (CoI) were used to guide the study. The CoI framework, originally derived from Wenger's (1998) communities of practice, is an established framework used to understand online learning. The CoI framework highlights social presence, teaching presence, and cognitive presence as the meaningful components that promote successful online learning experiences (Garrison et al., 2010). The three elements need to be present for knowledge to be constructed effectively. Garrison et al. (2010) stresses that an effective online learning environment is created when the learners and teachers skilfully and collaboratively organise these elements. The CoI framework is frequently used to examine the interactions in both synchronous and asynchronous online learning environments (Ndlovu & Mostert, 2018). Next, the three types of presence were discussed. Each of these types of presence has categories and indicators not discussed here because of the space constraints (Garrison et al., 2010; Ndlovu & Mostert, 2018).

Social presence is the ability of the learners to identify with the community, to communicate intentionally in a trusting environment, and to develop interpersonal relationships (Garrison et al., 2010). Cognitive presence is "the extent to which learners are can construct and confirm meaning through sustained reflection and discourse in a critical CoI" (Garrison et al., 2010, p.1). Teaching presence is the design, facilitation, and direction of cognitive and social processes to realise personally meaningful and educationally worthwhile learning outcomes (Garrison et al., 2010). It is seen "as a significant determinant of student satisfaction, perceived learning, and sense of community" (Garrison & Arbaugh, 2007, p. 163).

## 5. Research Methodology

### 5.1 Research Design

The study reported in this paper focused on the Grade 12 learners' perceptions of the ERTL of mathematics during the COVID-19 lockdown in a disadvantaged context. A descriptive mixed-methods research design was adopted. A descriptive research design describes a phenomenon and its characteristics (Gall et al., 2007). Gall et al. (2007) stated that it focuses on the "what" rather than the "how" or "why" an event has occurred. The data is usually collected using observations and questionnaires as the research instruments. A mixed methods research design integrates quantitative and qualitative data collection and analysis methods within a single study (Clark & Ivankova, 2016). The quantitative and qualitative data were simultaneously collected and analysed in this study. A Google-generated semi-structured questionnaire was used to collect the data.

Physical observations and face-to-face interviews were not possible in this study because of the need for social distancing required to minimise the transmission of the COVID-19 virus.

**5.2 Respondents**

Twenty schools in Gauteng, South Africa, were purposively selected. The purposive sampling of schools enabled the selection of information-rich learners for an in-depth study. The selection criteria included schools in disadvantaged contexts and whose Grade 12 teachers and learners had participated in the ERTL of mathematics during the COVID-19 lockdown (Chirinda et al., 2021). From a population of approximately 2300 Grade 12 mathematics learners, a sample size of 230 was determined by power analysis using the G*Power software (Cohen, 1988). We opted for G*Power software because it is free and easy to use. With Grade 12 classes at the selected schools as the strata, stratified random sampling was used to select the 230 learners. Stratified random sampling ensures that every stratum is adequately represented (Ackoff, 1953). It was applicable for use in this study because it was necessary to have every Grade 12 class at the selected schools represented adequately.

One hundred and thirty-seven of the selected 230 Grade 12 mathematics learners responded to the survey between the 28th May and 06th June 2020. This resulted in a 59.6% response rate. Of the 137 respondents, 65 (47%) were female, and 72 (53%) were male. The ages of the respondents ranged from 17 to 19 years old.

**5.3 Ethical Procedures**

Ethical clearance to conduct the study was sought and received from the overseeing university. Institutional entry permission was sought and received from the Department of Basic Education and specific school principals. Letters to seek informed consent were written to the respondents and to the parents or guardians of those below 18 years. The letters clearly explained, among other issues, the purpose of this study, the learners' role, and the importance of their voluntary participation. After understanding the content of the letters, the respondents aged 18 or above signed the consent letters to show that they voluntarily agreed to participate in the study. For the learners below 18 years, besides obtaining written parental or guardian permission, "assent" (Mertens, 2015, p.352) was sought and received by clearly explaining the study to the learners. Assent is a child's affirmation to participate in a study.

**5.4 Research Instrument and Procedure for the Data Collection**

The data were collected using a Google-generated semi-structured questionnaire, which the authors constructed. The questionnaire sought to establish the learners' perceptions of their experiences of the ERTL of mathematics during the COVID-19 pandemic. The first section of the questionnaire sought to determine the demographic characteristics of the learners. The second section investigated the social presence and had 14 closed-ended questions that covered five themes: (i) the learners' pre-COVID-19 experience with online learning, (ii) the availability and reliability of digital resources like a smartphone, internet access, etc., (iii) the effectiveness of ERTL, (iv) the support from parents or older siblings, and (v) the

conditions at home when studying. The third section consisted of two open-ended items that allowed the respondents to provide detailed information about their perceptions of the ERTL of mathematics during the COVID-19 pandemic.

The first open-ended item investigated the learners' cognitive presence: "What difficulties or challenges have you experienced or are you experiencing during the ERTL of mathematics?" The second open-ended item investigated the teaching presence, and it was "How does the teacher check your work?" A link was sent to the respondents via a WhatsApp text message since social distancing did not allow for physical contact between individuals. The respondents were required to click on the link that took them to the Google-generated semi-structured questionnaire. To create a sense of urgency, the WhatsApp message included a statement stating that the survey link would be active for five days only between 28th May and 01st June 2020. A friendly reminder was texted when the learners did not respond to encourage them to fill in and return the questionnaire. Most learners who had not responded by 01st June 2020 indicated that they could not afford the data to go online to respond to the questionnaire. The data for an internet connection was provided to these learners and in total, 137 responded to the questionnaire by 06th June 2020.

**5.5 Pilot testing of the Google generated semi-structured questionnaire**

The reliability and validity of the research instrument were upheld by pilot testing the questionnaire with seven Grade 12 learners from the same context. The learners in the pilot study did not participate in the main study. Pilot testing was also done to determine the practicability of the data collection process, the usability of the Google-generated semi-structured questionnaire, and the time required to complete it. We evaluated whether the questionnaire could be practically sent via WhatsApp messages, quickly received, and completed by the learners. In addition, pilot testing helped to determine the clarity, readability, and appropriateness of the questionnaire items.

The findings from the pilot study were that the questionnaire took an average of 15 to 20 minutes to complete. The learners are likely to respond to a survey that takes less than 10 minutes to complete (Koskey et al., 2015). Consequently, the questionnaire was adjusted to take approximately 10-12 minutes to complete to increase the response rate. Pilot testing revealed that the instructions were clear and appropriate for the study. Nevertheless, some questionnaire items were unintentionally repeated, and others were ambiguous. The duplicated items were deleted, and the ambiguous items were adjusted or simplified to suit the respondents' level. For example, the item "How do you evaluate the quality of the ERTL of mathematics compared to the usual face-to-face mathematics teaching and learning?" was changed to "ERTL is better than the usual class lessons at school." Four of the respondents in the pilot study inquired if they could change their answers at any point during the survey. The following statement was added at the beginning of the questionnaire: You may go back to change an answer at any time during the survey.

### 5.6 Data analysis

Descriptive statistics (frequencies and percentages) were used to examine the quantitative data on the learners' perceptions of mathematics learning during the COVID-19 pandemic. The study used descriptive statistics to transform the learners' responses into indices that characterised the data so then the readers can build a mental picture of how the data relates to the learners' perceptions of the ERTL of mathematics during the lockdown due to the COVID-19 pandemic (McMillan & Schumacher, 2014).

Two open-ended questions in the questionnaire provided qualitative data. The authors inductively analysed the qualitative data using a software-assisted content analysis method. The qualitative analysis software program, Atlas.ti, was chosen because it is user friendly. The content analysis began with developing a categorisation scheme that described the relevant coding categories (Züll, 2016). The categories were theoretically driven from the literature and empirically driven from the learners' responses. For the open-ended question on the difficulties or challenges experienced by learners during the ERTL of mathematics, four challenges were determined: inadequate explanation from the teacher, expensive data for internet connection, poor internet connectivity and, no physical classroom interaction with the teachers and other learners. For the question on how the teacher checked learners' work, two ways were established: I take a picture of my work and send via WhatsApp message to the teacher, and I do not have enough data to take pictures, so I try to type the answer.

After the coding process was completed, the credibility of the process was tested by engaging an independent coder. The findings were shared with each participant as a way of member checking, and revisions were done accordingly. The final codes were allocated a numerical value to understand the pattern of the data and its relationship to the learners' perceptions of the ERTL of mathematics during the COVID-19 lockdown.

## 6. Results

The quantitative and qualitative data results are presented in the following sections.

### 6.1 Quantitative Data

**(i) Prior experience with online learning**

Respondents were asked about their prior experience with any form of online learning. The question was "Did you attend any online mathematics lessons before the ERTL due to the COVID-19 lockdown? If so, where?" The results showed that eight learners (5.8%) had previously experienced online learning. The learners indicated that they had attended online lessons offered by non-profit organisations offering online after-school mathematics lessons to disadvantaged communities. The findings displayed that most of the respondents (94.2%) had never experienced online learning before the ERTL of mathematics during the COVID-19 lockdown.

**(ii)Availability and reliability of digital resources**

**Table 1: Learners' access to resources**

| Resources | Percentage (%) of learners with access |
|---|---|
| Reliable supply of electricity | 100 |
| Access to a smartphone | 89.8 |
| Stable and regular internet connectivity | 26.9 |
| Desktop computer, laptop, or tablet | 21.4 |

The participants were required to state their access to digital resources and other relevant resources during the ERTL of mathematics during the COVID-19 lockdown. The question was "What do you have access to?" The learners' responses to the question are presented in Table 1. The responses show that all learners had a regular electricity supply, and slightly above a quarter of the respondents had stable and regular internet connectivity. Almost 90% of the learners had access to a smartphone. To the respondents who had access to a smartphone, a further question was asked to establish if the learners owned the smartphone or if it belonged to a household member. The findings were that 74.5% of the 137 respondents personally owned a smartphone and 21 respondents (15.3% of the 137 respondents) used a smartphone that belonged to a household member.

The learners were asked about their experience with the ERTL of mathematics, and the findings are presented in Table 2. Most learners (88.5%) indicated that they understood the instructions given by the teachers during the ERTL of mathematics. Nonetheless, only 26.2% of the respondents stated they understood everything they learnt during ERTL. The majority of learners (94.8%) preferred the usual face-to-face class lessons at school. Close to 60% indicated that they did not benefit from the ERTL of mathematics during the COVID-19 pandemic. Most learners stated that they did not get support from either their parents or older siblings at home, and 76.9% did not have an appropriate space to study.

**Table 2: The effectiveness of the ERTL of mathematics**

| Items | SA/A F(%) | D/SD F(%) |
|---|---|---|
| ERTL is better than the usual class lessons at school | 3.4 | 94.8 |
| I benefitted from the ERTL of mathematics | 38.7 | 59.1 |
| I understood everything I learnt from the ERTL of mathematics | 26.2 | 69.6 |
| I understood all the instructions given by the teachers during the ERTL of mathematics | 88.5 | 10.3 |

| | | |
|---|---|---|
| I get support from home (it can be from parents or older siblings) | 29.4 | 66.0 |
| I have a space to study quietly at home | 17.6 | 76.9 |
| **NB**: F= frequency; %= Percentage; A=Agree; SA=Strongly Agree; D=Disagree; SD=Strongly Disagree | | |

### 6.2 Qualitative Data

Table 3 presents how the qualitative data was coded. For how the teacher checked the learners' work, 63 (46%) of the respondents stated that they took pictures of their work and sent them via WhatsApp message to the teacher. Additionally, 54% of the respondents indicated that they did not have adequate enough data to take and send images to the teachers, so they typed the answers.

**Table 3: Coding structure and frequencies**

| What difficulties or challenges have you experienced or are you experiencing during the ERTL of mathematics? | | | |
|---|---|---|---|
| **Codes** | **Open-Ended Responses** *(Direct quotes from learners)* | **Frequency** | **Percentage (%)** |
| Inadequate explanation from the teachers | No direct feedback. The teacher fails to explain the answers to problems in-depth on WhatsApp messages. The teacher gives brief answers. When we were learning in the classroom before Covid, I did not understand some things; now, it is even worse when we are learning from home, my maths teacher is not sufficiently explaining. | 78 | 57 |
| Expensive data for a stable internet connection | I only get a small amount of data per week from my parents. I cannot afford data to download school videos. I usually do not have data. My mum is no longer buying and selling fruits because of lockdown and cannot afford data for remote learning. | 117 | 85 |
| Poor internet connectivity | I cannot download large pdf documents because of a weak internet connection. We sometimes do not have network coverage in our area. | 102 | 74 |

| What difficulties or challenges have you experienced or are you experiencing during the ERTL of mathematics? | | | |
|---|---|---|---|
| No physical classroom interaction with the teacher and other learners. | I cannot get help from my classmates. No group work. No teacher to check how I am solving the problems. I cannot see the teacher's gestures. No opportunity to explain my solution to my classmates or my teacher. There is no one to tell me where I am wrong when working on mathematics problems. No interaction with my friends. I miss my teacher's funny facial expressions when he explains answers or new things. | 93 | 68 |

## 7. Discussion

The study reported in this paper investigated South African learners' perceptions of the ERTL of mathematics during the COVID-19 lockdown. Digital learning in mathematics gives learners the opportunity to learn content from the comfort of their homes (Mulenga & Marban, 2020). Nonetheless, most learners in this study did not have a comfortable or quiet place to study at home. All learners in the study had a regular supply of electricity and access to a smartphone. Nevertheless, only a few had access to a stable and regular internet connection. Upon being asked about the challenges they experienced during the ERTL of mathematics, most learners indicated that the data costs for the internet connection were unaffordable. The learners could not take pictures of their work and send images to the teachers. These findings highlight that it is challenging for learners in disadvantaged contexts to engage in productive mathematics learning through the WhatsApp platform. These findings contrast with the postulations of a study done by Mulenga and Marban (2020) in Zambia, a developing country like South Africa. The study projected that ERTL during COVID-19's school closures would stimulate the growth of digital learning in mathematics. Online learning in disadvantaged contexts appears impossible because digital learning's success depends on the learners' ability to attend online classes and the schools and teachers' ability to provide them (Murat & Bonacini, 2020).

Most learners in this study expressed that they neither enjoyed nor benefitted from the ERTL of mathematics and preferred face-to-face classroom interactions with the teachers. Learner and teacher face-to-face interactions are important because they open up opportunities for instant feedback and are viable for classroom explanations that pinpoint the learners' misconceptions and misunderstandings in mathematics (Black & William, 2009). Most of the learners also indicated that they preferred their teachers' gestures and facial expressions during mathematics learning. This means that the former continues to be an essential method of teacher communication during mathematics teaching (Alibali et al., 2014). This finding corroborates what Busto et al. (2021) unearthed from

their case study of university students and their professors at a university in Italy. Busto et al. (2021, p.21) found that "traditional blackboard lectures, including the gestures and facial expressions of the professor, are still a very efficient and highly appreciated means of teaching mathematics at the university."

Most learners stated that it was challenging not to work in groups while solving mathematics problems. Group work during mathematical problem solving is known to stimulate learners as resources for each other (Black & William, 2009). This could be why the learners indicated that they experienced difficulties learning mathematics on their own at home. Many learners expressed that it was complicated to learn mathematics without interacting with their classmates and not to get peer help. This finding aligns with Busto et al.'s (2021) findings that learners need to interact with each other to learn mathematics effectively physically.

The learners indicated that they could not learn mathematics productively at home since they did not have support from their parents or older siblings. The parents of learners in disadvantaged contexts typically work for companies that provide essential services that were required even during the COVID-19 lockdown. Consequently, these parents spend many hours at work such that they hardly are able to find the time to contribute meaningfully to their children's schoolwork. Some parents may be unemployed and staying full time at home. Nevertheless, illiteracy is common among adults who stay in disadvantaged contexts. They are unable to support their children in subjects like mathematics and science. All the same, grade 12 mathematics is challenging to most parents.

Most learners lamented that the teachers were not giving them either complete or adequate explanations of the concepts or problems given on the WhatsApp group chat. This could be because teachers were experiencing teaching through the WhatsApp platform for the first time. The teachers had to find solutions to the unfamiliar problems emerging daily from the digital environment that they were experiencing for the first time. On the other hand, Dube (2020) found that some teachers in resource-constrained contexts were not familiar with implementing online teaching and learning. For remote learning to occur successfully, teachers need to be skilful at teaching remotely besides the importance of having functioning ICT resources. In this case, the teachers had to suddenly become innovative and learn this new way of delivering mathematics lessons in a new environment. Besides, the teachers were affected by the COVID-19 pandemic like everyone else and had to cope with both personal and family challenges. Teachers could not send videos and PowerPoint narrated slides on the WhatsApp platform since the learners could not download them. It could be that the teachers relied excessively on worksheets to the disadvantage of genuine mathematical problem-solving and modelling. This finding may imply that WhatsApp as a learning platform in disadvantaged contexts is not effective unless supplemented by face-to-face learning. The findings from this study seem to suggest that teachers and learners in disadvantaged contexts not transitioning to online learning smoothly during ERTL contradicts Basilaia and Kvavadze's (2020) results from a study of ERTL in Georgia. They found that the transition to online was successful during

ERTL. Nonetheless, Basilaia and Kvavadze's (2020) study was at a private school and not at a public or government school.

## 8. Conclusion

The COVID-19 pandemic will end one day. Nonetheless, the way that mathematics is delivered may never return to pre-COVID-19 practices. Therefore, it is crucial to investigate the fundamental factors when using online methods to deliver mathematics in resource-constrained contexts. In this regard, this study focused on the following research question: "What are the learners' perceptions of the ERTL of mathematics during the COVID-19 lockdown in a disadvantaged context?" Most learners in the study stated that they neither enjoyed nor benefitted from the ERTL of mathematics and that they preferred face-to-face classroom interactions with the teachers. Most learners indicated that they were used to seeing the teachers' gestures, body language, and facial expressions and yearned for physical classroom interactions with the teacher and other learners. These findings seem to imply that learners in disadvantaged contexts could not learn mathematics productively at home since they did not have support from either their parents or older siblings.

Further findings were that the COVID-19 pandemic negatively impacted learners in disadvantaged contexts as they did not have adequate digital resources and internet connectivity to learn mathematics remotely in an effective way. It should be noted that pre-COVID-19, the use of digital resources for learning has been increasing in South Africa. Some education departments (e.g. Gauteng Department of Education) have launched digital educational platforms that focused on the curriculum delivery. Nonetheless, these platforms were meant to target ICT-enabled schools, which are rarely located in disadvantaged contexts. This could imply that effective online learning in disadvantaged contexts in South Africa is impractical at this stage.

## 9. Recommendations

The recommendations from this study are that government institutions in South Africa and worldwide must immediately implement digital transformation measures in education so then the gap between the rich and poor is lessened. This can be done by providing the learners in disadvantaged contexts with financial and digital resources and internet connectivity. This has been helpful in Europe where low-income households in the United Kingdom and Italy were provided with government support for online learning during the school closures that accompanied the COVID-19 lockdown (Murat & Bonacini, 2020). For mathematics teachers in disadvantaged contexts to contribute meaningfully to the digital transformation in mathematical teaching and learning, the authors recommend that they be given technical support and professional development in digital learning. In addition, South African pre-service mathematics education teacher programmes should focus on implementing digitalisation in mathematics education. The programmes should equip pre-service teachers with the knowledge and skills to enact digital tools effectively in their online teaching.

The sudden shift from face-to-face teaching to ERTL was significantly disruptive to mathematics learning. The learners' responses to the questionnaire enabled the

authors to identify the challenges related to the ERTL of mathematics in disadvantaged contexts. Further studies can be conducted to evaluate the impact of the Covid-19 pandemic on mathematics teaching and learning in different contexts in South Africa and worldwide with countries of different socio-economic statuses. The findings can inform the institutions of education and governments of the world on interventions that can be implemented to curb future disruptions in mathematics learning. The findings can provide teachers and educators with areas to reflect on in relation to the digital transformation in mathematics teaching and learning.

## 10. Limitations

This study has some limitations. The first limitation was that the study's findings were derived only from a survey investigating the learners' subjective perceptions. If telephonic interviews had also been conducted, the data would have helped the authors to delve deeper into the learners' thinking. The second limitation was in terms of representativeness in that the respondents were from a single province in South Africa.

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