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The effect of COVID-19 on inclusive mathematics education

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Abstract

The COVID-19 pandemic forced education to shift from face-to-face to online instruction, resulting in various technological, pedagogical, and social challenges. Oral hearing-impaired (HI) learners experienced difficulty participating in synchronous online lessons due to hearing devices not picking up sounds, slow typing speed, unfamiliarity with online devices, and emotional side effects. This study aimed to investigate the influence of COVID-19 on mathematics teachers' inclusive practices for HI learners. Using a case study design, data in the form of semi-structured interviews, observations, and document analysis were collected from two high school mathematics teachers before and during emergency remote teaching (ERT). The South African Department of Basic Education's guidelines for responding to learner diversity in the classroom and the design step in Whittle et al.'s (2020) ERT environment framework guided the analysis. The study found that teachers need adequate training and support when teaching HI learners. During the pandemic, HI learners were neglected as teachers focused on making videos and there was a lack of inclusive practices. Schools have a responsibility to provide technical training and support for teachers. Future research is needed to determine how the pandemic and the lack of inclusive practices affect HI learners' progression in mathematics, leading to a framework to guide inclusive mathematics teaching during future pandemics and ERT scenarios.

Keywords: inclusive education; mathematics; hearing-impaired learners; differentiation; emergency remote teaching; COVID-19; online learning

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Introduction

In January 2020 the world as we know it changed dramatically. On 30 January 2020 the World Health Organisation declared the COVID-19 outbreak a global health emergency, and on 11 March 2020 it was declared a global pandemic. Due to the COVID-19 outbreak, the President of South Africa, Mr Cyril Ramaphosa, announced a nationwide lockdown on 23 March 2020 for 21 days with effect from midnight 26 March 2020 (SAnews.gov.za, 2020). By implication, South African schools were not allowed to continue with face-to-face teaching in the second term on the scheduled date. However, the nationwide lockdown was later extended, resulting in South African schools being closed for more than two months before the phased-in return of learners was allowed. Reimers and Schleicher (2020) state that the COVID-19 pandemic is likely responsible for a generation's biggest disruption in educational opportunities worldwide. Institutions had to hastily respond to a suddenly forced transition from face-to-face to remote teaching (Carrillo & Flores, 2020) as a primary strategy to slow down the infection rate through social distancing (Mohmmed et al., 2020; Reimers & Schleicher, 2020). Continuing teaching during COVID-19 was a challenge for every teacher and even more so for teachers of inclusive schools. To accommodate HI learners in the face-to-face inclusive classroom, mathematics teachers have to apply certain inclusive practices. But how did the mathematics teachers accommodate HI learners during remote teaching? Thus, the research question that guided this study is: *What is the influence of COVID-19 on mathematics teachers' inclusive practices for HI learners?*.

Literature Review

The following literature review provides background to the research question: *What is the influence of COVID-19 on mathematics teachers' inclusive practices for HI learners?* It outlines discussions on inclusive education, the HI learner, ERT in response to the COVID-19 pandemic, and the challenges faced by HI learners during the COVID-19 pandemic.

Inclusive Education

Inclusive education has become an important topic (Schwab & Alnahdi, 2020) and is a complex concept (Ackah-Jnr, 2020; Haug, 2017; Lindner et al., 2019; Roos, 2019)

as it has varied conceptualisations within education systems and schools (Ackah-Jnr, 2020; Dela Fuente, 2021; Haug, 2017). Researchers refer to the term inclusion either as ***an ideology/ideal or a way of teaching/practice/actions*** (Antia & Stinson, 1999; Bešić et al., 2017; Finkelstein et al., 2019; Haug, 2017; Hill & Rahaman, 2013; Mitchell, 2015; Roos, 2019). UNESCO (2005) lists four key elements regarding the concept of inclusion—namely, that inclusion is a process; it has to do with the identification and eradication of barriers; it is about the "presence, participation and achievement of all students" (p. 15); and it "involves a particular emphasis on those groups of learners who may be at risk of marginalization, exclusion or underachievement" (p. 16).

Inclusion is more than just reconstructing provisions for learners with disabilities; it is the extension of educational opportunities to a wide range of minority groups who may historically have limited access to schooling (Dyson & Forlin, 1999; UNESCO, 2005). The South African Department of Education (DoE, 2001) distinguishes between *inclusion* and *mainstreaming or integration*. Inclusion's primary attribute requires that the system adapt, whereas mainstreaming or integration requires that the learner change to fit in (DoE, 2001; Jenkins et al., 1990).

The hearing-impaired learner

The context of the study is the inclusion of HI learners in the general mathematics classroom wearing hearing aids and/or cochlear implants and having moderate to profound hearing loss in both ears. However, these learners are able to communicate orally and do not use sign language. Even though HI learners' intellectual abilities parallel those of normal hearing learners (Salend, 2011) and their hearing loss was detected at an early stage, on average HI learners' achievements continue to lag behind their typical hearing peers (Pakulski, 2021). HI learners experience many barriers to learning including listening, spoken language, comprehension, curriculum, learning material, and exhaustion (Alasim, 2018; Luckner et al., 2012; Salend, 2011; Uys & Selesho, 2017). In addition, HI learners entering high school have an average language delay of four-to-five years, therefore these HI learners are unprepared for the language demands of the high school curriculum (Furlonger et al., 2010).

Classroom instructional practices can cause barriers for the HI learners such as:

- the pace of instruction of the curriculum being too fast and not accommodating the HI learner (Alasim, 2018; Berndsen & Luckner, 2012;

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DoE, 2001; Uys & Selesho, 2017)

- a lecturing, non-interactive teaching style
- lessons not being broken down into smaller sections and not being reinforced with activities
- HI learners being unaware of the purpose of the lesson and the connection to real life
- lessons not being taught in a routine-like and sequential way (Uys & Selesho, 2017)
- a high number of speakers involved in a conversation (Berndsen & Luckner, 2012)
- a lack of visual support (Erbas, 2017; Uys & Selesho, 2017)
- unfamiliar vocabulary used by the teacher, as HI learners' vocabularies are relatively limited (Erbas, 2017; Uys & Selesho, 2017).

Emergency remote teaching in response to the COVID-19 pandemic

As mentioned in the introduction, academic institutions worldwide were forced to cancel face-to-face teaching due to the COVID-19 outbreak (Mohmmed et al., 2020). In response to the pandemic, many schools implemented remote teaching (König et al., 2020; Morgan, 2020) for learning to continue. Hodges, Moore, Lockee, Trust, and Bond (2020) suggest the term *emergency remote teaching* (ERT) as "a temporary shift of instructional delivery to an alternate delivery mode due to crisis circumstances" (p. 6), providing temporary access to instruction in a manner that is quick to set up and is reliably available during an emergency or crisis. Why, however, is it not called *online learning*?

Research provides evidence that effective online learning results from the careful design and systematic development of instructional material such as a fully online university course being planned, prepared, and developed within six to nine months (Hodges et al., 2020). The COVID-19 pandemic caused a global emergency response in the education sector and teachers had to react without sufficient preparation (Mohmmed et al., 2020). As a result, many online learning experiences were not fully featured or necessarily well planned and were in clear contrast with what many know as high-quality online education. Therefore, the term *emergency remote teaching* is more applicable (Hodges et al., 2020). Various instructional delivery methods are widely used in education such as online lectures, recorded lectures, voice over PowerPoint

slides (PPT), and massive open online courses (MOOC).

There is a stronger emphasis on asynchronous rather than synchronous learning in ERT as households with many family members and few devices have competing needs (Reich et al., 2020; Snelling & Fingal, 2020). ERT should emphasize independent learning rather than compliance with activities, so that learners can become self-learners (Mohmmed et al., 2020, Reich et al., 2020, Snelling & Fingal, 2020). As students and learners might not be able to attend courses immediately, asynchronous activities might be more feasible than synchronous ones. However, younger learners benefit from the structure of required synchronous sessions (Hodges et al., 2020), especially since they have no experience working on their own.

Ferri, Grifoni, and Guzzo (2020) classify the challenges of ERT as technological challenges, pedagogical challenges, and social challenges. Technological challenges include the unreliability of internet connections and the lack of necessary electronic devices. In contrast, pedagogical challenges are mainly associated with teachers' and learners' lack of digital skills, learners' lack of motivation and self-management, and teachers' lack of social presence (Ferri et al., 2020). The lack of human interaction between teachers and learners, and between learners and learners is a social challenge, as is inadequate physical space at home to receive lessons and the absence of support from parents working remotely in the same location (Ferri et al., 2020).

The transition to ERT forced many teachers to acquire new technologies and skills, causing stress among teachers and learners (Smith, 2020). Teachers responsible for ERT course activities had a huge responsibility (Hebebci et al., 2020). They worked long hours learning to change and redesign their lessons (Donitsa-Schmidt & Ramot, 2020). Teachers also experienced an increase and change in workload and realised that ERT could support learning for many learners, however, it should be carefully designed and individualised so as not to exacerbate inequality and social divides (Kaden, 2020).

Challenges faced by hearing impaired learners during the COVID-19 pandemic

Only a few studies were conducted on the challenges of hearing impaired (HI) learners during the COVID-19 pandemic (Krishnan et al., 2020), none from South Africa. Teaching learners with disabilities during COVID-19 had its challenges and many learners were impacted physically and mentally and their interactions may have been hindered (Krishnan et al., 2020). Teachers who lacked technology training

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and resources experienced many challenges when teaching learners with disabilities online (Smith, 2020), therefore ERT was not as effective as the face-to-face education that learners with disabilities receive at school (Morgan, 2020). According to Smith (2020), many learners with disabilities find an online learning schedule difficult as they need a more structured learning environment and interaction with their teachers and peers. If HI learners cannot follow the teacher's progress, they may not learn effectively (Krishnan et al., 2020).

The reported challenges HI learners experienced during COVID-19 relate mainly to synchronous teaching and learning. Their hearing devices were not able to pick up speech or sounds completely and accurately, they were not able to type their questions fast enough during synchronous online lessons, and they were not familiar with online devices such as laptops, smartphones, Skype, Google Classroom, Zoom, etc. The HI learners also experienced emotional challenges as they felt the pandemic had ruined them and they could not anticipate how online classes would be carried out (Krishnan et al., 2020). According to Kritzer and Smith (2020), HI learners experienced challenges related to teachers forgetting to caption materials and too many faces appearing on a Zoom screen which made knowing where to look to follow a discussion difficult. The rate of caption flow being faster than learners could process and the reading level of text presented in videos and visual materials being beyond learners' reading levels also challenged the HI learners.

Conceptual framework

The conceptual framework combines the South African guidelines for teaching diverse learners (Department of Basic Education (DBE), 2011) and the design step of Whittle et al.'s (2020) ERT environment framework. It was used to determine how the COVID-19 pandemic influenced mathematics teachers' inclusive practices when teaching HI learners—particularly during ERT. Following is a discussion on the first part of the conceptual framework, namely, the South African guidelines for the teaching of diverse learners (DBE, 2011).

South African guidelines for the teaching of diverse learners

The South African Department of Education (2001) recommends in White Paper 6 that the process of learning and teaching should be flexible enough to accommodate

ISSN 2788-6298

different learning needs and styles. In other words, differentiation should take place. According to the *Guidelines for responding to learner diversity in the classroom through curriculum and assessment policy statements* (DBE, 2011), differentiation in the curriculum and assessments should occur in response to the inclusion of diverse learners and their needs. The following is a discussion of the differentiation in the curriculum and assessments as recommended by the DBE (2011).

Curriculum differentiation: consists of three aspects, namely, differentiating curriculum content, differentiating the learning environment, and differentiating teaching methods (DBE, 2011). Let us briefly look at each aspect.

(1) *Differentiating curriculum content:* Teachers are encouraged to modify the curriculum content, which can be done at three levels, namely, abstractness, complexity, and variety (DBE, 2011). *Abstractness* refers to the fact that some learners may need to access content first at a concrete level, that many aspects of the curriculum can be very *complex* and difficult to grasp, while *variety* indicates the expansion of the curriculum to prevent learners from getting bored (DBE, 2011).

(2) *Differentiating the learning environment*: There are two learning environments: the psychosocial learning environment and the physical environment (DBE, 2011). The psychosocial learning environment "covers psychological and social factors that have consequences for satisfaction, health, well-being and ability to perform effectively, including effective communication, and classroom and school culture" (DBE, 2011:6). The physical environment includes factors such as noise levels, seating arrangements, and resources which are applicable to HI learners (Deafness Foundation & Deaf Children Australia, 2005; Erbas, 2017).

(3) *Differentiating teaching methods*: Learning materials, methods of presentation, learning activities, and lesson organisation are all part of the differentiation of teaching methods (DBE, 2011). Teachers should adapt instructional methods and materials to suit learners' needs (Buli-Holmberg & Jeyaprathaban, 2016). Regardless of teacher education programmes and professional development, workshops and other offerings should be implemented to prepare teachers with strategies to increase visualisation skills to enhance HI learners' ability to unpack concepts and words from long-term

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memory (Lang & Pagliaro, 2007). The DBE formulates this as follows: "Curriculum differentiation is a key strategy for responding to the needs of learners with diverse learning styles and needs … within a differentiated curriculum, assessment of learners and their learning is integral to the teaching and learning process" (DBE, 2011:4).

Differentiating assessment: Too often teachers think of assessments as tests, whereas they should think of these as road maps for their thinking and planning (Tomlinson, 2017) to develop their inclusive practices. In answer to the question, "What do we assess?" the DBE (2011) replies with four answers, namely: assessing to determine readiness and learner pre-skills, assessing progress with the curriculum, assessing learner interests, and assessing learner characteristics. When differentiating assessments teachers can use Bloom's Taxonomy as it reflects a spectrum of task difficulty. They can follow procedures such as designing assessment tasks for different learning styles or intelligences, allowing for group assessment tasks, pacing or scaffolding the assessment activities, allowing for tests and assignments to be taken orally as well as in written form, having multiple-choice options, allowing learners extra time, and varying assessment activities (DBE, 2011).

There are alternate forms of assessment for learners with disabilities. *Alternate assessments based on alternate attainment of knowledge* apply to learners with a significant cognitive disability, while HI learners without a significant cognitive disability, for example, can have *alternate assessments based on modified attainment of knowledge and alternate assessments based on grade-level attainment of knowledge* (DBE, 2011).

> *Alternate assessments based on modified attainment of knowledge:* Due to barriers to learning caused by a disability, the learner might need more time to master the content. Assess the learner's mastery of grade-level content with reduced load/more at a functional level (DBE, 2011).
>
> *Alternate assessment based on grade-level attainment of knowledge:* This involves learners with disabilities such as HI learners who need, for example, additional time, readers, and amanuenses because these "procedures provide them with equal opportunities to demonstrate their attainment of content which is at the same grade-level as the general assessment" (DBE, 2011:19). HI learners in South Africa are eligible for differentiated assessments and accommodations in the National Senior Certification Examination in response to their learning

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barriers. The accommodations include the adaptation of questions, additional time of 20 minutes per hour for perusal/formulating/writing/checking answers, computer/voice to text/text to voice, oral examination, reader, rest breaks, scribe, separate venue, spelling, and video/DVD recorder/webcam (DBE, 2014).

The next section comprises a discussion on the second part of the conceptual framework, namely, the design step of Whittle et al.'s (2020) ERT environment framework.

Emergency remote teaching environments framework

Education researchers need to rethink methodologies and theoretical frameworks to grasp the educational realities that emerged during the COVID-19 pandemic (Khirwadkar et al., 2020) because the mode of delivery changed dramatically. The role of the teacher cannot be underestimated during such a time. Therefore, it is crucial to facilitate teachers' professional collaboration and learning, and give teachers access to online resources so they can support learning for their learners (Reimers & Schleicher, 2020).

Whittle et al. (2020:311-312) propose a framework for ERT environments to "address moments of crisis in which teaching environments can only be understood circumstantially and supported provisionally". The framework consists of three non-linear and iterative steps: inquiry of circumstances of and resources available to teachers and learners, classifying available resources into constants and variables, and designing education experiences (Whittle et al., 2020). The study only focused on the *design* step of the ERT environments framework.

There are eight dimensions in the design step, namely, critical learning goals, the ratio of teacher to learners, communication method, building agency, assessments, the social role of the instructor, pedagogy and the learner's social role, and feedback (Whittle et al., 2020). These are discussed below in relation to the inclusion of HI learners.

- *Critical learning goals*: Teachers need to identify critical learning goals that can be guided by constants or variables (specific goals identified for specific learners) (Whittle et al., 2020). These may include encouraging HI learners to read independently before each class to develop their reading skills (Krishnan et al., 2020), since HI learners' vocabularies are relatively limited (Erbas, 2017;

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Uys & Selesho, 2017).

- *Ratio of teacher to learners*: The necessary differentiation and individual support are difficult to achieve in large classes (high ratio of learners). Thus, wherever possible, learners with barriers (LSEN) should be taught in smaller classes (Blatchford & Webster, 2018). During ERT, the ratio concern was especially apparent once teachers considered their social presence in the classroom (Whittle et al., 2020).
- *Communication method*: Teachers must decide on a communication method: either synchronous or asynchronous learning strategies once they have determined their learning goals. At first, teachers felt synchronous teaching was best. However, it was demonstrated that asynchronous learning is beneficial when learners are engaged in activities not bound by the classroom's time constraints (Whittle et al., 2020). To overcome challenges HI learners face, teachers should ensure learners use a frequency modulation (FM) system if online classes are equipped with them. Teachers need to use a hearing aid microphone and ensure that the setting lessens background noise (Krishnan et al., 2020). HI learners prefer a visual learning style. So teachers should distribute notes digitally to their learners and provide them with enough time to process the subjects being taught (Krishnan et al., 2020).
- *Building agency*: The learners' ability to learn in their own homes and at their own pace might allow teachers to engage learners on topics and approaches of particular interest instead of general lessons and formats (Whittle et al., 2020). Learners might experience a taste of more independence and take on new responsibilities for their learning (Kaden, 2020).
- *Assessments:* Assessments were deprioritised at the beginning of ERT as teachers saw assessment expectations as unfair during the COVID-19 pandemic (Whittle et al., 2020). Teachers felt that learners focussing on grades or teachers focussing on learner evaluations during the COVID-19 pandemic could result in more challenging crisis management as the goals of teachers and administrators would be in conflict (Whittle et al., 2020). However, it became apparent that it would be difficult for teachers to determine learners' needs, and to create adequate lesson plans in the long run if they did not conduct online formative assessments (König et al., 2020). On the other hand, assessments can be individualised using technology to

showcase the learning and skills of learners, and large-scale standardised testing may become outdated (Kaden, 2020).

- *Social role of the instructor*: Teachers build relationships with parents to gain insight into the learners' needs and environmental constraints. This parental connection provides "context for the social presence of the teacher" (Whittle et al., 2020, p. 317). The parents of HI learners need advice, knowledge, and assistance for learners to be appropriately guided. Institutions should provide health assistance, including managing anxiety (due to social distancing) and counselling centres for online assistance if needed (Krishnan et al., 2020).
- *Pedagogy and the learner social role*: A socially driven pedagogical approach to enhance learner engagement and participation (Whittle et al., 2020) can be achieved by employing a problem-posing pedagogical approach (Olawale et al., 2021). HI learners struggle if the instructions are only expressed verbally, therefore teachers should modify and customise their teaching practices and keep in mind that HI learners need assistance with the use of technology (Krishnan et al., 2020).
- *Feedback*: Learners need to get feedback. Therefore, teachers should make use of alternative feedback strategies such as non-graded formative feedback, self-feedback, and peer feedback (Whittle et al., 2020). During synchronous sessions, teachers need to remember that HI learners might seem to daydream; their talking may not be clear; they might not understand the given instructions; and they may have poor performance, especially concerning language (Krishnan et al., 2020).

At the beginning of the study, the plan was to conduct research in inclusive schools to explore the inclusive practices of six mathematics teachers regarding HI learners in at least three inclusive schools in Gauteng. However, due to the COVID-19 pandemic, the study had to be adapted to the new circumstances as visits to public schools were not possible. Fortunately, research had already been conducted at a private inclusive school before the pandemic. The original conceptual framework relating to face-to-face teaching which included the *Guidelines for responding to learner diversity in the classroom through curriculum and assessment policy statements* (DBE, 2011) was adapted to include ERT. The design step of the ERT environment framework (Whittle et al., 2020) was used to incorporate inclusive practices in the study. The rationale for including the ERT environment framework as an inclusive practice, is that during the

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classify step of the framework one needs to determine the factors that are *constants* and *variables*. And in doing so taking note of the diversity and applying that knowledge to one's practice. In other words, it becomes inclusive practice.

Method

The nature of the study can be described in terms of three assumptions: ontological, epistemological, and methodological. The ontological position taken in this study is idealism, which asserts that reality is only knowable through the human mind and through socially constructed meanings (Nieuwenhuis, 2016). Regarding the epistemological assumption, it is believed that the voice of insiders should be heard, taking into account what people say, do, and feel, and how they make meaning of the phenomena under investigation (Nieuwenhuis, 2016). Knowledge for this study is acquired through deductive logic which involves a top-down approach to knowledge as a theory is derived from a hypothesis which is tested against observations about the world (Ormston, Spencer, Barnard & Shape, 2013). An interpretive position is taken in this study as human experience can only be understood from people's views. The study requires an idiographic methodological preference which aims to identify patterns of behaviour within the person across a population of experiences or situations (Conner, Tennen, Fleeson & Barrett, 2009).

A qualitative approach was deemed appropriate, with a case study being the best choice for in-depth investigation of mathematics teachers' inclusive practices during face-to-face teaching and the effect of COVID-19 on their inclusive practices due to ERT (Timmons & Clairns, 2010). Social constructivism as a research paradigm underpinned this study and is often combined with interpretivism (Creswell & Creswell, 2018). Interpretivists believe that reality is not objectively determined but socially constructed. Therefore, there is a greater opportunity to understand people's perceptions of their activities when they are studied in their natural environment (Nieuwenhuis, 2016).

The trustworthiness of qualitative research is highly significant (Nieuwenhuis, 2016), encompassing the collection, organization, and categorization of data (Di Fabia & Maree, 2012). Qualitative researchers often use the terms "validity and reliability" to denote research that is considered "credible and trustworthy" (Nieuwenhuis, 2007). According to Gibbs (2018), validity refers to the accuracy and truthfulness of

explanations, while reliability involves consistent results across different investigations. Patton (2002) links quality and credibility, stating that judgments of quality form the basis for perceptions of credibility. He replaces validity and reliability with the concept of credibility, which depends on rigorous fieldwork methods, the researchers' credibility, and a philosophical belief in qualitative inquiry. These criteria aligned with the study's approach, as it adopted a qualitative case study design to investigate inclusive education. Rigorous standards were maintained during data collection and analysis, without seeking evidence to support a preconceived position.

Although researchers may be inclined to favour certain themes or create biased conclusions (Creswell, 2014), efforts were made to avoid such biases. Creswell and Creswell (2018) advocate for incorporating validity strategies, including triangulation, member checking, rich descriptions, and acknowledging researcher bias. These strategies were implemented in the study. The study employed a DEDUCTIVE-inductive data analysis approach, with a focus on deductive analysis based on pre-determined categories from the conceptual framework.

As researchers, it is imperative to respect the rights, needs, values, and desires of the participants (Creswell & Creswell, 2018). Permission was obtained from the Ethics Committee at the University of Pretoria to ensure adherence to research ethics standards. The research ethics application covered various aspects, including research approach, design and methodology, voluntary participation, informed consent, anonymity, and risk.

The research site was an inclusive private high school in Gauteng, South Africa, where HI learners are included and taught alongside their hearing peers. The school was purposefully chosen due to its inclusion model, as HI learners are fully included and attend the same classes and lessons as their hearing peers. Consent was obtained from the private schools' director and high school principal via email after explaining the research focus. A discussion was held with the mathematics HOD and the deputy principal responsible for the HI learners. Participants were invited and informed about the study's purpose and their role. Teachers had the choice to participate and were aware of their right to withdraw at any stage. Consent from mathematics teachers and parents was obtained through signed letters, while learners provided assent through signed letters. The limited number of available teachers was considered and handled ethically. To ensure confidentiality and anonymity, pseudonyms were assigned to each participant.

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Although physical or psychological harm is highly unlikely, participants may have experienced privacy invasion during recorded lessons and felt anxiety and discomfort during interviews. Participants were assured that they could choose not to answer specific questions and that pseudonyms would be used to protect their identities. The school and participants' names were not mentioned during the dissemination of the study. Ethical considerations for working with disabled learners were addressed with appropriate measures. The small number of HI learners in the private inclusive high school was a vulnerable population and was addressed with all the ethical requirements. Video recordings did not show the faces of HI learners; only the teachers' faces were visible as recordings were made from the back of the classroom.

The sample consists of two out of the three mathematics teachers of the inclusive high school, each teaching at least two classes of the same grade, where one class includes HI learners and the other does not. The decision was made to observe the teachers teaching both classes to assess the teachers' inclusive practices when instructing HI learners in one of the two classes. The third teacher was excluded as she did not teach two classes from the same grade, with one class having HI learners and the other one not.

The Grade 10 teacher (from now on called Francis) was 37 years old and had 14 years of experience teaching mathematics. However, she had only started teaching at the private inclusive school in 2020. The class without an HI learner consisted of 16 learners, while there were 13 learners in the class containing the HI learner. For the twenty-five-year-old Grade 9 teacher (from now on called Debbie), 2020 was her third year of teaching and her second year at the private inclusive school. She had one more year of experience teaching at the particular inclusive high school than Francis. In the Grade 9 classes she taught, the class containing the HI learner had 21 learners and there were 23 learners in the class without an HI learner. Before the pandemic, data was collected through face-to-face semi-structured interviews, observations, and document analysis. An interview protocol was utilised for the semi-structured interviews in this study. The protocol was developed in advance and consistently applied to all participants, following the recommendation of Creswell and Creswell (2018). Two semi-structured interviews were conducted per teacher to gain insight into their inclusive practices. One interview was held face-to-face during traditional teaching, prior to any observations, while the second interview was conducted via Zoom following the first ERT period in 2020. The duration of the initial interviews

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was 36 and 46 minutes for Debbie and Francis, respectively, and were conducted after school hours. The follow-up interviews were held after school hours and during a free period, lasting 40 minutes for Debbie and one hour for Francis. The aim of the follow-up interviews was to examine the inclusive school's mathematics teachers' response to the COVID-19 pandemic and their experiences with ERT. Audio recordings of the interviews were made to assist with the data analysis. The recordings were transcribed verbatim after which the coding took place.

The type of observation used was that of the observer as a participant. The researcher's role was known and field notes "on the behaviour and activities of individuals at the research site" (Creswell & Creswell, 2018:262) were documented. An observation protocol was compiled in advance to cover the predetermined aspects of inclusive practices and contained demographic information about the time, place, and date of the field setting (Creswell & Creswell, 2018). The purpose of the classroom observations was to describe the inclusive school's mathematics teachers' inclusive practices for HI learners. Four lessons per teacher were observed. The first two lessons were the same lesson taught to two different classes. One class had HI learners and the other class was without HI learners. The third and fourth lessons were based on the same principle, one class had HI learners while the other class did not have HI learners.

The trustworthiness of the study is enhanced when multiple data collection strategies such as multiple observations, interviews, documentation, and audio-visual digital materials are used. The data collected during ERT consisted of all the teachers' videos, documentation (assessments, worksheets, etc.) uploaded onto Google Classroom during a nine-week ERT period, and a Zoom interview with each teacher. Only six randomly chosen videos uploaded by each participant over the course of ERT were analysed. To mitigate discomfort during the Zoom interview, participants were provided with the questionnaire in advance, allowing them time to consider their responses.

Presentation and Discussion of Findings

During the first interview with each teacher, it became clear that neither of the two teachers had received or read documentation and guidelines from the DBE on inclusive education. Thus, they had not heard of the *Guidelines for responding to teacher diversity*

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in the classroom through curriculum and assessment policy statements from the DBE (2011). When asked what inclusive practices Francis applied, she only referred to the Roger and Soundfield system as a listening device that the private inclusive school provided for them, the daily extra academic lesson, and extra classes after school. Francis felt that she did not have to adapt her way of teaching, while Debbie believed she was capable of making the necessary instructional modifications for the HI learners. She was aware that HI learners have vocabulary and comprehension barriers. Francis did not yet understand the barriers HI learners have such as the vocabulary and comprehension barriers and how these should be addressed, while Debbie understood the learning barriers HI learners have relating to vocabulary and speech, as literacy is crucial for HI learners.

The following section presents the findings relating to the conceptual framework.

Curriculum differentiation

From the class observations, it was evident that the learning environment contained technology support in the form of a Soundfield and both teachers wore a Roger Dynamic around their necks. Sometimes Francis and Debbie forgot to mute the Soundfield when assisting individual learners and all the learners could clearly hear what was said. In both teachers' classes the particular HI learner was positioned correctly: more to the front and directly in front of the board.

Francis wrote the daily homework on the board and referred the learners in both classes repeatedly to the information on the board. Debbie, on the other hand, only mentioned the homework and had to repeat it several times as the learners could not remember what she had said. In contrast to Francis, Debbie did not talk while writing on the board, so the HI learner did not struggle to lip-read. During the observations, neither of the participants rephrased words as part of vocabulary support for the HI learners. Both teachers only made use of learning on an abstract level and thus did not differentiate the content based on the abstractness. There was evidence that both teachers differentiate the mathematics content by addressing the different levels of complexity of the questions, namely, knowledge, routine, and complex procedures in the examples they do in class and for homework. Only Francis made use of problem solving. Debbie would make use of procedures or steps to show the learners how certain calculations should be done. Unfortunately, neither of the teachers incorporated variety into their lessons as the instructions were the same for every learner, whether HI or not, and neither of the two participants incorporated

ISSN 2788-6298

different intelligences as suggested by DBE (2011).

Every fourth lesson of every day was an extra academic period at the school where the teachers did not carry on with work but rather gave all the learners extra worksheets to complete. The one teacher described it as an enrichment class. During this period the HI learners would go for tutorials where they received specific help on the subject they needed help with. Both Francis and Debbie explained during the interviews what *rephrasing* was. However, the examples both provided were inappropriate and not executed sufficiently. Neither of the participants rephrased words as part of vocabulary support for the HI learners during the observed face-to-face lessons.

During ERT the two teachers did not do anything special or different to assist the HI learners. Hardly any differentiation was implemented during ERT. They did not rephrase unfamiliar or difficult words to assist the HI learners. Sometimes Debbie only said difficult words verbally with no visual explanation. Both teachers mainly instructed learners on what to do and spoke quite clearly and audible. Debbie's face was visible as a video feed for difficult videos and her mouth was always visible. By doing so, the HI learners could lip-read. However, it was not clear why Debbie did not do this with all the videos.

Differentiating assessment

Both Francis and Debbie said that the HI learners received the same test for their assessments as the other learners. Assessments were deprioritised during ERT as the learners did not write a June examination during ERT. Both teachers gave the same assessments to the HI learners as the rest of the learners. The method of assessment for Francis and Debbie differed noticeable. Debbie set multiple-choice quizzes for the learners with the use of Google Forms. These consisted of differentiated questions and although the learners could only choose one option as their answer, the mark allocation alternated between one and five marks depending on the complexity of the question. Google Forms marked the questions automatically. On the other hand, Francis provided the learners with four assessments on PowerPoint (PPT) slides, traditional questioning with some consisting of old examination papers. Neither of the participants knew whether someone assisted the HI learners at home with the assessments: helping them to understand what should be done.

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Critical learning goals

Francis was well prepared for all her face-to-face lessons with the necessary PPT slides and it was evident that she knew what she wanted to achieve during each lesson; having clear goals was important. When there was a scheduled double lesson on the timetable, the second of the two lessons was always used for geometry. So, each period was a new lesson that she had planned containing new goals. Francis mentioned she was aware that there were different ability learners in her class. Debbie knew what she wanted to teach in the observed lessons, however, it seemed that she was not that well prepared for the lessons. She sometimes used different examples with the Grade 9 classes and did not have copies of a worksheet ready for the first class earlier in the morning. The learners had to copy the homework questions from the board before doing them.

During ERT, both teachers uploaded weekly planning on a Monday on Google Classroom and determined the critical learning goals before recording the videos. In the videos the topics of the lessons were on the front slides, and the learners could see what the teachers would be discussing in the video. Only Debbie identified variable factors as she added her face to difficult videos. By doing so, she could show manipulatives and explain certain topics such as the surface area of a 3D-object, thereby presenting the information on a less abstract level.

Ratio of teacher to learners

The Grade 10 class without an HI learner had 16 learners and the other class with an HI learner in the class comprised 13 learners. Both classes were therefore small (Blatchford & Webster, 2018). Francis was aware of the mixed-ability group of learners in both classes. The two English classes Debbie taught consisted of 23 and 21 learners. She was very comfortable with the learners, and she controlled the class situation well. During ERT, Debbie had to take over one Grade 8 class from Francis, while Francis took over two classes from the HOD. For Francis, the increased number of learners played a huge role in the marking of the digital assessments. Her whole marking process was cumbersome and time-consuming as she could not make ticks and provide feedback on the scripts.

Communication method

Teaching prior to the COVID-19 pandemic and ERT was face-to-face (equivalent

ISSN 2788-6298

to synchronous). From the beginning of the year and before the lockdown, the teachers had access to Google Classroom where they could upload worksheets and the learners could access them asynchronously, however, this was not really utilised. As instructed by the school, both teachers made use of asynchronous teaching by making videos during ERT, even though Morgan (2020) feels it is unreasonable to expect teachers to compile their own resources. They also had a few synchronous Google Meet sessions where the learners could ask questions. The school focused more on the communication method than on the learning goals as they first decided on the communication method instead of letting the teachers determine each lesson's critical learning goals. For a perfect online lesson, Francis and Debbie preferred synchronous teaching where they could write and the learners could follow and ask questions—similar to a face-to-face lesson.

Building agency

All the lessons Francis taught were general lessons and all the learners in Francis' class had to do the same work. She did not use topics and approaches of particular interest to engage the learners. Debbie gave real-life examples applicable to rate. One learner was very interested in the example and wanted Debbie to show her how to solve the indirect proportion question. Unfortunately, at first Debbie did not know how to do the calculation and had to consult the internet. It was evident from the data analysis that neither of the teachers used ERT as an opportunity to engage learners on topics and approaches of particular interest. Their videos were instructed lessons where they explained new formulae or methods to the learners.

Assessments

Neither of the participants individualised the assessments: all the learners had to do the same assessments during face-to-face teaching and ERT. In other words, no inclusive practices relating to assessments were followed.

Social role of the teacher

At the time of the first interview, Francis had only been teaching for four weeks at the inclusive school and had had limited time to contact the parents and gain insight into the learners' needs and environmental constraints. She mentioned that the parents should make sure that the learners understood, however, she did not state that she

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informed the parents thereof. During the class observations, Francis handed out the learners' class tests and requested from the learners that the parents sign the tests. As this was the second year Debbie had taught the learners, she presumably already knew more about the learners and their circumstances. However, she had not realised (known) that the class that presumably did not have an HI learner actually had one.

Francis mentioned that the school expected the teachers to be in contact with the learners often during ERT. The HOD assisted with the communication with the learners and parents. Francis said that sometimes she had to write emails to the parents. The parents also emailed her during ERT saying their child could not submit the work due to certain circumstances.

> *Well, they expected us to stay in regular contact with the children, through Google Classroom, but our Head of Department (HOD) took over most of the communication. Where children needed to be contacted personally, she did it. For example, she contacted children who did not submit their work and I also sent occasional emails to parents and so on.* (Francis)

Neither Francis nor Debbie was involved in sorting out the learners' access to devices and internet or following up to make sure that the learners were coping during ERT. Francis assumed that the HI learner coped well as she thought he had earphones that would help him. This is evidence that Francis did not understand the barriers to learning that the HI learners experienced and thus did not apply inclusion properly. Debbie said she was not sure what the home situation of the HI learner was, and whether there was someone at his house that could assist him or not. Although Debbie had the minimum of social contact with the learners, she spoke to them in some of her videos, telling them how much she missed seeing them. Learners preferred videos made by their own teachers because they loved to hear their teachers' voices.

Pedagogy and the learner social role

The dynamics of the class without an HI learner were such that the learners barely participated, and Francis just continued with her explanation. Francis would not necessarily wait for the learners to answer her questions. She would ask a question and immediately give the answer, such as

> *"Can I take the common factor from those two, yes, I can take out an x. Can I take the common factor from those two? Yes, I can take out a minus y".* (Francis)

Both teachers experienced the classes containing the HI learners as more engaging, and in Francis' case she could not even complete the same amount of work as she did in the other class. Debbie tended to ask more learners by name in the class without the HI learner, as, like she explained, the learners in that particular class did not answer by themselves and she tried to get everyone to work. The learners would sit and wait and see what Debbie did, while the learners in the class with the HI learner tended to put up their hands and were eager to answer. Again, this was not due to the presence of an HI learner but rather due to the dynamics of the class. Neither Francis nor Debbie followed a problem-solving approach that would prompt the learners to construct their own understanding.

Francis said it was difficult for her to determine whether the learners understood the work during ERT as they copied so much of the assessments from others, and she did not see the learners face-to-face. Debbie made the remark that most of the learners did not even actually watch the videos. At one stage, Debbie requested that the learners give their answers to the question in the comment section on Google Classroom. Debbie urged the learners in her videos to contact her if they had any problems. Neither of the teachers had a social-driven approach with the learners during ERT. The lack of interaction was caused by the asynchronous approach.

Feedback

During face-to-face teaching, Francis was keen to compliment learners when they answered something correctly, while even though Debbie tended to repeat the learners' answers, she would not always tell them whether their answers were correct or not. Debbie would explain how the calculation should have been done without giving feedback to the learners with the incorrect answers. She gave opportunities for learners to show their methods for doing a calculation. She then explained to the class what the learners did and complimented the learners on their methods. Francis also complimented learners' correct answers as it is necessary to motivate and encourage learners in mathematics.

During ERT the feedback Debbie gave her learners, was their marks for their

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assessments and answering questions, while Francis said her feedback consisted of the learners' marks together with a short personal report for their assessments. Francis also mentioned that she had to answer the learners' questions on Google Classroom.

Conclusion

The study investigated the teachers' inclusive practices during face-to-face teaching and ERT due to COVID-19. It revealed that both teachers had limited inclusive practices during face-to-face teaching and did not do anything special to support HI learners. As a result, the HI learners were neglected during ERT. The two teachers were not aware of the *Guidelines for responding to teacher diversity in the classroom through curriculum and assessment policy statements* from the DBE. Francis believed that she did not have to adapt her teaching method for HI learners, while Debbie was aware of the learning barriers HI learners face. Both teachers made use of technology support, and the HI learner was positioned correctly in front of the whiteboard. Neither of the participants rephrased words as part of vocabulary support for the HI learners. Even though both teachers differentiated the mathematics content based on the complexity of the questions, they gave the same assessments to the HI learners as to the rest of the learners, and they did not incorporate different intelligences as suggested by the DBE (2011).

It is important for teachers to have a thorough understanding of the obstacles that learners with hearing impairments face so that they can respond appropriately. Lesson planning is essential in any school or classroom, but it is especially important in an inclusive setting to avoid teaching generalised lessons. Both teachers in this study taught lessons that were applicable to all learners, regardless of whether they had a hearing impairment or not. During ERT, asynchronous teaching was used, resulting in less interaction and feedback between teachers and learners. In hindsight, the teachers preferred synchronous teaching during ERT. They did not receive any training or support to assist them with ERT, leaving them feeling unsupported. Francis wished for technical training, while Debbie wished for reliable technology and fewer strict requirements regarding video appearance, feeling that her teaching style did not align with the school's expectations. The teachers found teaching to be a demanding job, with high expectations from the school, and they were overwhelmed.

What was, thus, the effect of the COVID-19 pandemic on inclusive mathematics

ISSN 2788-6298

education? The HI learners were neglected during ERT.

Recommendations

Based on the findings, here are some recommendations for improving ERT for both teachers and learners, particularly for those with hearing impairments:

- Provide training and support: Teachers need adequate training and support to effectively teach during ERT. Schools should invest in providing training on technical procedures and tools for ERT. This can help teachers feel more confident and comfortable with the technology and reduce their workload.
- Use synchronous teaching: Teachers should aim to use synchronous teaching wherever possible. This approach allows for real-time interaction with learners, which is particularly important for learners with hearing impairments who may require additional support.
- Adapt lessons for diverse learners: Teachers should aim to adapt their lessons to meet the needs of all learners including those with hearing impairments. This may involve using closed captioning, providing written transcripts of videos, and using visuals to supplement auditory content.
- Provide feedback: Teachers should aim to provide regular feedback to learners including HI learners. This can help learners stay engaged and motivated, and ensure they are progressing with their learning.
- Provide reliable technology: Schools should ensure that teachers have access to reliable technology that is suitable for ERT. This can help reduce the stress and workload for teachers and ensure that lessons run smoothly for all learners.
- Manage workload expectations: Schools should be mindful of the workload expectations placed on teachers during ERT. Providing adequate support, resources, and training can help teachers manage their workload and prevent burnout.

By implementing these recommendations, schools can provide more inclusive and effective ERT for all learners, including those with hearing impairments.

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