concentrating, or paste worksheets upside down and has trouble sitting still" (Q4).

Teacher D (Group 2) stated that neurodevelopment is:

"I think when based on children's neurodevelopment, it is the brain capacity of a learner's brain" (Q5).

She further explains ADHD as:

"a deviation in the brain and it is also a part of the brain that does not work, it is a neurological thing" (Q6).

Teacher E (Group 2) indicated, just as Teacher C, that she had never heard of the term neurodevelopment. She explains it as:

"I believe it is the way the brain thinks and more the psychological part of the brain." (Q7)

She further explains ADHD as:

"A chemical imbalance in the brain. It is some kind of a dysfunction in the brain" (Q8).

It was clear that most participants did not understand the term neurodevelopment. During the interviews, teacher B searched for the definition of neurodevelopment and ADHD. She read the answers from her computer, clearly showing that she does not know the answer. The participants did, however, have some comprehension that ADHD is caused by an injury in the brain but could not elaborate on that. According to a study conducted by Daniel Sheppard (2022), a better understanding of the neurodevelopment of learners diagnosed with ADHD would help to understand the difficulties the learners experience when doing mathematics or any other subject better. This understanding will also help to elucidate the impact of cognitive difficulties on their daily life and inform effective strategies at school and home.

4.4.1.2 The importance of neurodevelopment in respect of ADHD

According to Sjöwall and Thorell (2022), previous research has emphasised the importance of viewing ADHD as a disorder related to neurodevelopmental deficits such as executive deficits, delay related behaviours, and emotional dysregulation. Bakker (2015) laid the groundwork for Sjöwall and Thorell (2022), stating that neurodevelopment plays an important role in the diagnoses, learning, and behaviour of learners identified with ADHD. The teacher needs to understand that the brain of an ADHD learner takes more time to mature. The most

noticeable growth delays in an ADHD brain are at the frontal lobe of the brain. The frontal lobe of the brain controls cognition, attention, and planning. This can cause challenges with the learner's attention because of the disorder ADHD causing a dysfunction in the brain. Teachers can help improve this challenge by focusing on the correct classroom setup and planning worksheets and activities according to the learners' challenges.

According to Teacher A (Group 1):

> *"Neurodevelopment is the study of the brain that have a connection with each other" (Q9).*

Teacher D (Group 2) added:

> "*I see ADHD as a deviation in the brain"* (Q10).

Moreover, Teacher C and Teacher E from Group 2 mentioned that they realised, neurodevelopment can be connected to ADHD. In the opinion of Teacher C, teachers should be made aware of the understanding of young ADHD-identified learners' development. Sjöwall and Thorell (2022) mention that it has been shown that the overlap between working memory, inhibition, and speed of processing information is more significant in children diagnosed with ADHD. Teacher D (Group 2) had some understanding that the learning capacity of the brain of ADHD learners is more complex. Bakker (2015) states that the brain is an important determinant of an ADHD learner's mental functioning, development, and health.

According to Teacher E (Group 2):

> "*ADHD is a chemical imbalance in the brain."* She added: *"a dysfunction in the brain"* (Q11).

Underdevelopment and malfunctioning of certain parts of the brain have become an accepted explanation for children diagnosed with ADHD. At the same time, however, most teachers are not knowledgeable enough to understand the neuroscience of the disorder ADHD (Bakker, 2015). Furthermore, based on the experience of Teacher A and Teacher B from Group 1 they felt they were not taught well enough about the brain, emotions, and understanding of ADHD learners. Sjöwall and Thorell (2022) agree with Teacher A and Teacher B and state that there are not enough studies to examine the extent to which emotion dysregulation overlaps with other neurodevelopmental deficits concerning children diagnosed with ADHD.

Teacher B (Group 1) and Teacher C (Group 2) stated that they think ADHD is “hereditary”. Genetic factors have been described as playing a major role in the development of ADHD (Getz, 2013). Carter (2019) agrees with Getz (2013) and states that faulty genes or developmental problems during gestation or infancy can cause some disorders. The neurodevelopment of a learner with ADHD is important to understand because it can help make learning and teaching for these learners easier.

4.4.1.3 Impact of ADHD on learners’ cognitive development and learning

Executive deficits are significant in the cognitive development and learning of ADHD learners. These deficits can cause hyperactivity, impulsivity, inattention, emotion regulation, and long- and short-term memory challenges in the cognitive development of young learners diagnosed with ADHD (Sjöwall & Thorell, 2022). According to Bakker (2015), ADHD disorder was a childhood mental disease-causing overactivity, restlessness, distractibility, and a short attention span in the cognitive development of learners, and it was diagnosed by psychiatrists and school physicians. Sheppard (2022) further states that ADHD can make daily tasks, such as remembering homework, bringing the correct equipment to school, difficulty understanding the teacher's instructions, or struggling to complete tasks difficult for learners. In the 1950s, ADHD was labelled as a brain injury/brain dysfunction causing hyperactivity in learners and adults and called “hyperkinesis” at the time (Bakker, 2015:354). Bakker (2015:355) further states that ADHD can also cause learners to be “easily distracted” and is a form of “restlessness”. According to Muñoz-Silva *et al*. (2022), ADHD can cause or form part of other learning disabilities and disorders in learners' cognitive development, such as dyslexia, dyscalculia, dyspraxia, and autism.

Teacher C (Group 2) gave a brief explanation of one of her learners that corresponded with the information of the resources mentioned above, stating:

> *“I would say it is when a child does not necessarily understand concepts but there are certain factors that cause the child to not be able to understand something in class. Like for example he is too busy, or has trouble concentrating, or paste worksheets upside down and has trouble sitting still” (Q12).*

Furthermore, Teacher A (Group 1) mentioned:

"I have to use different types of teaching aids in order to help teach them because they do not always keep attention if you just talk about the concept you need to get something to get their attention" (Q13).

According to both Sjöwall and Thorell (2022) and Bakker (2015), the three neuropsychological deficits of ADHD, hyperactivity, impulsivity, and inattention can play an important role on learners' cognitive development and make the learning of difficult tasks in mathematics much more challenging. Furthermore, ADHD can also cause other dysfunctions in emotions, such as anxiety, aggressiveness, depression, and feeling overwhelmed.

Teacher B (Group 1) stated:

"They feel very uncertain about themselves even though they have the ability to get the correct answer" (Q14).

Furthermore, Teacher C (Group 2) stated:

"If you start your morning with a busy or moody attitude the learners will definitely pick it up and also act busy, difficult, or very emotional" (Q15).

Teacher D by the same token mentioned:

"They are very emotional sensitive. I cannot afford to walk in my classroom with a negative attitude. Negativity is like throwing petrol on fire for them. If they get emotional it is not a good thing. Children diagnosed with ADHD act different than learners who are not diagnosed with ADHD if they get emotional. The learners will withdraw and not want to work" (Q16).

Furthermore, Sjöwall and Thorell (2022) state that studies have measured emotional lability/impulsivity in learners diagnosed with ADHD such as being easily frustrated and losing their temper.

4.4.2 Teachers' perspectives about ADHD neurodevelopment and mathematical interventions in the Foundation Phase.

According to David (2020), further studies are necessary to develop training programmes that would prepare teachers better for the education of gifted children and children with learning disabilities such as ADHD, especially in mainstream schools.

In supporting the literature, a perspective that Teacher A (Group 1), Teacher D (Group 2), and Teacher E (Group 2) had in common was that they wanted to learn more about the

neurodevelopment of learners diagnosed with ADHD to help improve the mathematics interventions they use.

Teacher E (Group 2) stated:

> *"I would like to study further one day to educate myself more about ADHD-diagnosed learners" (Q17).*

She claimed that there are some concepts that she does not always know how to convey more clearly to her ADHD-identified learners.

As the researcher observed Teacher A and Teacher B (Group 1), they appeared to have a more concerned perspective about how they should learn and transfer mathematics interventions to ADHD-identified learners in their classrooms. According to the participating teachers from Group 1, they felt that some challenges affect their ability to incorporate good mathematics interventions. They further explained that this includes the lack of materials they have which can cause them to be unable to convey a concept clearly, and the worksheets with explanations in the learner's mathematics books are not always understandable or on the learners' level of education.

Teacher C (Group 2) mentioned that she believes the curriculum's mathematics interventions only work best with sufficient repetition and hard work.

Teacher D (Group 2) stated:

> *"I actually have a broad perspective on the mathematical interventions for learners diagnosed with ADHD. The reason is because I have a learner who does well in mathematics and then I have a learner who does badly in mathematics. I can experience both sides and experience that some of the mathematics interventions help learners but others not so much. I have to for example use a stretch band for one learner that I put around her legs to help her with hyperactivity and distractibility while some of my other learners sit on special cushions to help them with concentration while they do mathematics, where other learners just need a picture or blocks to help them" (Q18).*

According to Teacher D, her perspective is that mathematics interventions work best for her ADHD-identified learners when she uses ADHD resources such as textured materials, bands, cushions, and fidgets.

During the interviews, it seemed that Group 2 was more equipped with concrete materials than the teachers from Group 1. According to the White Paper 6 policy, educational structures, systems, and methodologies must meet the needs of learners with learning barriers.

Teachers A and B from Group 1 also mentioned that the mathematics curriculum is too difficult and overwhelming for them. They claimed that certain mathematical concepts needed more explaining and one-on-one intervention, making teaching difficult. Furthermore, the Education White Paper 6 policy also mentions that learning needs may arise because of an inflexible curriculum, and inappropriate and inadequate support. The teachers from Group 1 mentioned that they did not receive enough support and therefore struggled to implement mathematics interventions for learners with ADHD.

Some of the participating teachers' perspectives appeared negative, because, according to them, they do not always have enough materials to apply the mathematics interventions when they do complicated mathematics. Teacher B from Group 1 mentioned that she and Teacher A must share concrete materials when they work with concepts such as multiplication, halves, and patterns. However, they are not always equipped enough for that. There was a clear difference in the teachers' perspectives in Group 1 and Group 2, mainly depending on their circumstances.

4.4.2.1 Mathematics interventions aligned with the curriculum.

Mathematics interventions are methods and ways to make the learning and teaching of mathematics easier for children who are behind or with any neurodevelopmental challenges (Nel *et al*., 2013). According to Maringe and Prew (2015), the curriculum is more than just a plan for teaching and learning in schools. It encompasses a variety of activities, processes, inputs, outputs, and outcomes that explain and form decisions about the teaching and learning of mathematics in schools. Furthermore, the Curriculum and Assessment Policy Statement has been designed as a framework to guide the teachers on different ways to assess learners throughout the year. However, CAPS was also subjected to critique. Mathematics has been seen as ‘content-dense’ in some grades, compromising the quality of teaching and the opportunity for the learners to attain expected competencies (Maringe & Prew, 2015).

According to Nel *et al.* (2013), the curriculum can be seen as inflexible and not responding to the needs of a wide variety of learners diagnosed with learning difficulties. This shortcoming leads to complications such as inappropriate teaching and learning and the belief that all the learners have to "fit into" the same system. In supporting the literature above, the perspectives of each teacher were mentioned and aligned with the curriculum to determine if the curriculum's mathematics interventions work and, if not, what the reason could be.

Teacher E (Group 2) mentioned that she would find it very helpful to study further one day to educate herself more on the neurodevelopment of ADHD-identified learners. White paper 6 notes that teachers must get enough training to broaden their knowledge of complex mathematics concepts that must be taught to learners with learning barriers. The researcher concluded that the participating teachers in Group 1 did not receive much training, and the training received by Group 2 was not always helpful. This could make teaching difficult mathematics concepts mentioned in the curriculum more challenging for the teachers.

Teacher B (Group 1) mentioned that some mathematics concepts are too difficult for learners diagnosed with severe ADHD or ADD. According to Manicka (2018), a study found the curriculum very burdensome and rigid for learners with disorders. Furthermore, making the mathematics curriculum accessible to learners with or without learning barriers involves modifying, changing, adapting, extending, and varying teaching methodologies, teaching strategies, assessment strategies, and curriculum content (Nel *et al*., 2013). Teacher A (Group 1) stated that they do not always have enough time to support the learners on a level expected from them.

Teacher C (Group 2) stated:

> *"I believe that the mathematics interventions that we use works, but it is still hard sometimes. You really have to try to keep the attention and repeat the work numerous times for the ADHD learners while also working with learners that have no learning impairments" (Q19).*

According to the curriculum, repetition is very important, especially when the learners have to do mental mathematics related to multiplication.

Teacher D (Group 2) mentioned that she uses ADHD resources such as textural materials,

cushions, and fidgets. The curriculum mentions that teachers can use materials that can help support the learners with mathematics interventions. Furthermore, she observes the learners' work often and uses real-life examples. This method is also aligned with the curriculum.

Furthermore, Teacher E (Group 2) mentioned:

> *"Some of the mathematics interventions from the curriculum work. Although I have realized that when my ADHD-diagnosed learners do not drink their medication, they will struggle regardless of the mathematics interventions" (Q20).*

Teacher E adds that a few interventions mentioned in the curriculum can be described as successful. These include breaking steps down into smaller pieces to help ADHD-identified learners with their memory. She also claimed that giving clear directions and explanations for the learners' work is mentioned in the curriculum.

According to Greenblatt (2017), repeating work is one of the golden nuggets to help learners diagnosed with ADHD to remember difficult steps. Learners with ADHD usually lack iron, and iron-deficient children score poorly in mathematics (Greenblatt, 2017). Therefore, if necessary, medication for concentration and to boost the brain is very important regardless of the interventions given to teachers. Manicka (2018) agrees with the importance of the correct medicine and adds that inclusive education and mathematics interventions can only be possible if the curriculum considers all children.

During the observations, the researcher realised that the teachers' worksheets are not always set up correctly as mentioned in the curriculum. The curriculum states that teachers must use physical helping aids, pictures, patterns, and supporting materials to help teach learners with ADHD. These include number lines, images used to describe multiplication, multiplication tables, diagrams to record multiplication facts, concrete apparatus, worksheets with pictures (for work sums about multiplication), and row patterns (for repeated addition leading to mathematics). The figures below illustrate examples from the curriculum which explain the above information.

Figure 4.5: Examples of flow diagrams from the curriculum

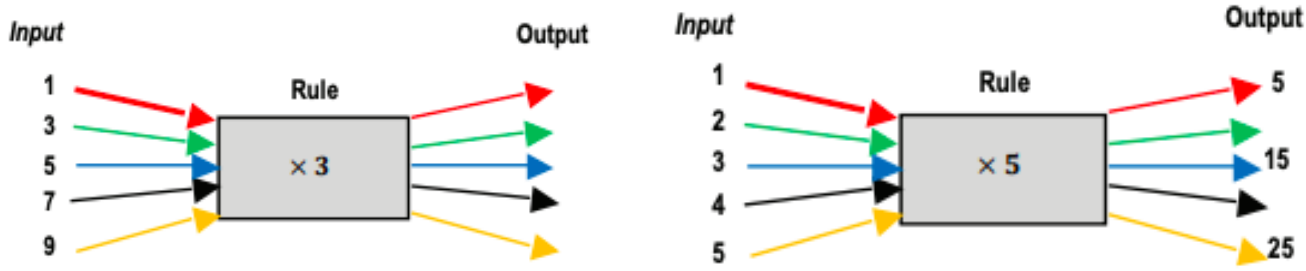


Figure 4.6: Examples of multiplication tables from the curriculum

×	2	3	4	5	6	7	8	9	10
1									
2									
3									
4									
5									

Figure 4.7: Examples of useful multiplication strategies using "doubling" from the curriculum

Fill in the times five row. What patterns do you see?

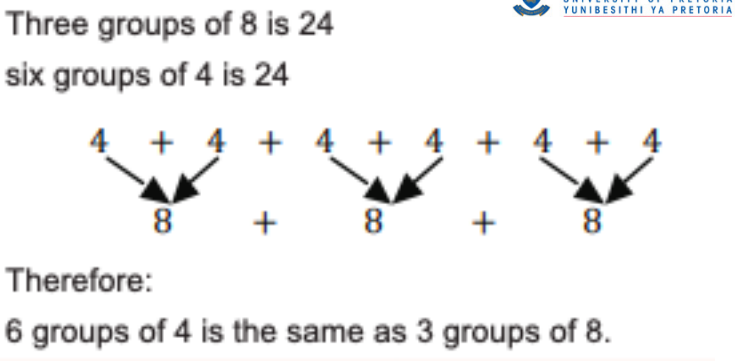
	1	2	3	4	5	6	7	8	9	10
× 5										
× 10										

Double the numbers in the times five row to get the numbers in the times 10 row. What patterns do you see?

Fill in the times two row.

	1	2	3	4	5	6	7	8	9	10
× 2										
× 4										

Double the numbers in the times two row to get the numbers in the times four row. What patterns do you see?



Figures used from the CAPS policy Statement document (DBE, 2011:340).

The figures above are examples from the curriculum about methods teachers can use to teach mathematics (multiplication) using semi-concrete objects for ADHD-identified learners. It also illustrated how teachers should design the tables, number lines, or grouping of numbers according to a specific pattern. The curriculum also mentions that teachers are allowed to tell learners with learning disorders or any neurodevelopmental challenges to use concrete apparatus or draw pictures to support them with challenging activities. Furthermore, the curriculum states that teachers must use systematic and explicit instruction when explaining concepts, visual representations such as manipulatives, pictures, graphs, and extra assistance.

4.4.2.2 Grade 3 teachers' perspectives about mathematics interventions for learners diagnosed with ADHD in the Foundation Phase.

According to Pratt (2002), teachers' perspectives are broader than mere teaching methods. Nel *et al.* (2017) explain teaching perspectives as beliefs that direct teaching actions and methods. During the interviews, it was clear that each teacher had their own perspective on the mathematics interventions they used in classrooms. Some participants had a positive perspective; others appeared more negative as they expressed their perspectives. There are different types of interventions teachers can use when ADHD learners struggle with mathematics because of their hyperactivity or distractibility. The teacher must, among other things, allow the learner to stand up and stretch their body when the learner is losing concentration (Mash & Wolfe, 2010). According to Sjöwall and Thorell (2022), brain gym activities can also support learners who struggle with distractibility or lose concentration. These interventions include cross crawl, brain buttons, drawing the lazy 8, hook-ups, and thinking caps.

According to Teacher A's statement, she had more of a negative perspective about some interventions in the curriculum. According to her, not all mathematics interventions work, and it depends on the learner's capacity. She stated: *"I think that some of the work is too difficult for learners diagnosed with severe ADHD*" (Q21).

Teacher C stated that her ADHD-identified learners need more "one-on-one" time when completing mathematics that they find challenging, regardless of the interventions given by the curriculum. She also mentioned:

> *"I do give them more attention and time. If I explain challenging mathematics concepts, I will repeat it to them again before they start their work. Sometimes I have to go back one step again with them and start with the basics" (Q22).*

Teacher D (Group 2) claimed that she has a "broad perspective" about the mathematics interventions, where she appeared more positive about her opinion. According to Teacher D, some interventions will work well but not with every learner. She claimed that the interventions taught to teachers are only compatible with an average learner and depend on the learner's individual capabilities. It depends on how that learner learns and understands the mathematical concepts given to them.

According to Nel *et al.* (2013), when teachers use mathematics interventions with learners diagnosed with ADHD, they have to listen attentively and respond as positively as possible when teaching them. Pratt (2002) earlier expressed the same sentiment as Nel *et al.* (2013), stating that for teachers to teach more effectively, they need to be caring and fair, have a respectful attitude towards the teaching profession, socially interact with ADHD learners with enthusiasm, be motivated for learning, and practise reflection. Teacher E also appeared optimistic when she spoke about her perspectives. She claimed that her best intervention strategy is to break the work down into smaller steps, although it is time-consuming. The paragraph below explains the challenges the participating teachers face when implementing the mathematics interventions linked to the curriculum. These challenges will give a better understanding of some of the participants' negative perspectives on the mathematics interventions used.

4.4.2.3 Challenges teachers face in implementing mathematics interventions.

According to Meier and Naude (2014), some challenges teachers can face when implementing mathematics interventions for learners with ADHD can be a loss of concentration. This loss of concentration is caused by mathematics, which can become boring, too difficult, or overwhelming for ADHD-identified learners. The information above can be used to support the statements of Teacher A, Teacher B, and Teacher C. According to the participating teachers, the learners forget steps (long multiplication), and they demonstrate a lack of understanding of some concepts, such as patterns and mental mathematics. Their attention deficit and distractibility influence their performance.

According to Teacher A (Group 1): *"I have one learner that struggles with mathematics interventions even when I give examples on the whiteboard over and over" (Q23).*

Teacher B (Group 1) that stated: *"It is difficult, even though you are using different teaching methods" (Q24).*

Furthermore, based on participant A's experience, she believes that when a teacher uses mathematical interventions, it is important to adapt teaching methods to accommodate the ADHD learner's needs. The challenge is that teachers do not always have the time or concrete apparatus/resources to adapt for specific learners. Teacher A and Teacher B (Group 1) also have to share the concrete materials. They complain that sometimes it can cause frustrations if one teacher needs something, and the other teacher has the materials; this can waste time.

Teacher D and Teacher E (Group 2) mentioned that using the "break instructions down into smaller pieces" strategy can be very time-consuming. ADHD-identified learners need extra time for teaching and learning because of their lack of concentration and hyperactivity, regardless of the mathematics interventions. Teacher A and Teacher B also mentioned the lack of time as a challenge caused by the poor concentration and memory of their ADHD-identified learners. Teacher B stated: *"I use small clocks, and it helps them a lot. But they do not like the clocks it makes them nervous" (Q25).*

Teacher C (Group 2) stated: *"The only way of working with the learner is one-on-one and to make sure he/she keeps up with the work. It requires a lot of time, work, and difficulty" (Q26).*

Bos *et al.* (2007) state that sometimes, the lack of concentration or distractibility can be caused by sensory hyperactivity. Nel *et al.* (2013) agree with Bos *et al*. (2007) and further state that a learner identified with ADHD in a classroom requires good planning by the teacher to ensure the learner is kept interested all the time. Too much visual and auditory stimulation in a classroom can cause ADHD learners to overreact and get out of hand (Bornman & Rose, 2010). Nel *et al.* (2017) agree and state that inappropriate learning styles, such as using the same teaching style every day, can cause challenges in teaching to ADHD-identified learners. In support of the study, it was clear that the teachers from Group 1 found their classrooms challenging to incorporate suitable mathematics interventions. During the observations, the researcher observed small classrooms with little space. The classrooms were tight, and teachers sometimes had to pass through each other's classes to go to the bathroom. The children's tables and chairs were also very close to each other, which caused overstimulation for the ADHD-identified learners. This led to a lack of concentration and frustration among the learners.

According to Teachers A and B (Group 1) and Teachers C, D, and E (Group 2) another challenge is the anger, aggression, irritability, and emotions of the learners diagnosed with ADHD. Teacher C (Group 2) mentioned that she sometimes struggles with her ADHD learners' emotional regulation if they are not in a good mood, which makes teaching difficult. She stated: *"They act busy, difficult, or very emotional" (Q27).*

Teacher E (Group 2) agrees and mentioned: *"A negative attitude will definitely cause my ADHD learners to be more busy or emotional, and then I will struggle to get work out of them" (Q28).*

The participants also mentioned that finding additional time for preparing lessons and materials is a big challenge as they are overwhelmed with work. The teachers from the private school (Group 1) mentioned that they have to create new mathematics books themselves every term with worksheets, which is extremely time-consuming and overwhelming. If teachers face challenges when teaching mathematics, they must put more time into their work and seek support (Nel *et al*., 2017). The problem remains that the teachers get little support from the schools and DBE. Below, the challenges of support were discussed further.

4.4.3 The support teachers receive

According to Nel *et al.* (2017), teachers should get support from the South African Education Districts Based Support teams for lesson planning, classroom management, resources, and intervention provision.

4.4.3.1 Types of support teachers receive from the school.

During the interviews, the researcher observed negative body language from Teachers A and B (Group 1) when they spoke about support. According to Teacher A, the teachers from her school only receive little support from the school principal and management. Teacher A claimed they have to buy their own concrete material because of the schools' lack of finances.

Teacher B (Group 1) stated:

> *"From the school self, such as the principals and management we do get enough support and advice on how to teach learners struggling with ADHD. We also get some concrete tools from the school, but we also have to buy our own helping aids if we want more, nor do we have many workshops to spread our knowledge" (Q29).*

The participants from the mainstream school (Group 2) seemed content when they were asked about support from the school. Teacher C (Group 2) claimed:

> *"We get a lot of support from our school. We are constantly asked what training we need, but the only thing is there is not always time for some of those training. Our principal of academics is assigned to the subject of mathematics, and we especially get a lot of support from her" (Q30).*

Teacher D (Group 2) stated:

> *"Yes, we definitely get support from our school. We get workshops regularly and concrete materials and resources that we can use. We do not have to buy anything; the school provides us with that" (Q31).*

Teacher E (Group 2) agreed with Teachers C and D and further stated: *"We definitely get support from the school self, and they provide our concrete materials; we do not have to buy anything ourselves" (Q32).*

4.4.3.2 Types of support teachers receive from the DBE

When the researcher asked the participating teachers from Group 1 about the support from the DBE, they both seemed frustrated. According to Teacher A, the teachers from her school do not receive much support from the DBE, in this regard she stated:

> *"Okay, so from the DBE I do not think there is any support there, because they just expect you to teach according to the curriculum. They do however tell you that you can use teaching aids to assist the teaching of difficult mathematics. But it does not always work, because children with ADHD don't, they don't keep their full attention and they need something more concrete, they have to do something physical with their bodies in order to learn when they do mathematical concepts otherwise, they do not learn" (Q33).*

However, Teacher B stated: *"I personally feel that we do not get enough support from the district-based support teams" (Q34).*

The teachers from Group 2 seemed content about the support they receive from the DBE, and they mentioned that the support they are given is not always helpful. Teacher C maintained the following:

> *"We did, however, have one training from the Department of Education but to be honest the level of this training was not really on the same educational level of our learners. It was far too easy for them. They, for example, spend one full day explaining the concepts of double and halving. They explained work that we already know, so it kind of felt like wasting time" (Q35).*

According to Teacher E: "*Yes, we do get support and guidance from the Department" (Q36).*

According to the White Paper 6 policy, teachers must get further training about learners with learning barriers and remediation. Suppose teachers are not consistently trained and updated about the neurodevelopment of learners with learning barriers. In that case, it can have a negative outcome on the learning and future of those learners. Private schools mostly get their support from student tuition and scholarships. During the research study, the researcher could observe a lack of finances from Group 1 (private school), causing the teachers to lack the necessary funding support they need. It was also clear that the teachers from Group 1 had to purchase and supply most of their materials themselves, and they did not receive

enough training to enhance their knowledge about ADHD-identified learners. However, the teachers from Group 2 appeared very optimistic about the support they received from the school and the DBE. The researcher could not notice any lack of finances in the Group 2 school, and they also appeared content with their knowledge of difficult mathematics concepts. The participating teachers from Group 2 were clearly more knowledgeable regarding mathematics interventions.

4.4.4 Inclusive strategies used to help learners diagnosed with ADHD

According to Nel *et al.* (2013), the essence of inclusive strategies that are used to help ADHD-identified learners access mathematics concepts is to match the teaching and learning to the learning profile and to keep their learning barriers in mind when offering choices of what and how to learn and how to demonstrate mathematics learning.

4.4.4.1 Strategies and methods participating teachers used to make challenging mathematics easier for learners diagnosed with ADHD.

i. Physical bodies

According to Teacher A, she motivates her learners to make use of their "bodies" when doing mathematics. Bornman and Rose (2010) state that teachers can provide more opportunities for ADHD-identified learners to make use of their bodies and hands to help with their restlessness and distractibility.

Teacher D stated:

> *"I especially use the "body" method when doing word problems. I explain to the learners that there are three steps, and they make use of their bodies to remember the three steps. If we do open [a] number sentence, they make a square in front of their face. I believe that they should use their bodies to help remember the work" (Q37).*

ii. Repeating method

Teacher A also mentioned that she uses the repetition method for learners to internalise concepts taught; she stated: *"I basically repeat the work daily so that it helps them with memorialisation" (Q38).*

Teacher B also used a repetition method and mentioned that she gives examples on the whiteboard "over and over." Furthermore, Teacher C claimed the only way to keep the attention of her ADHD learners is to "repeat" the work numerous times.

iii. Concrete material methods

According to all five participants, the best strategies and methods to use include concrete materials. This includes materials and physical objects that can be seen and touched. Teachers A and B mentioned using counting cubes, key cards, and number cards.

Teacher D stated:

> *"I have a lot of learners on medication, so I make use of many concrete materials to support them. I make use of pictures, counting cubes, and their bodies" (Q39).*

> *"I make use of different textured teddies that the children can play with if they feel overwhelmed. I also like to give the learners a break if I see that they are distracted. There is also an App that I use; they call it Dojos. So, it is very cute; you determine the rules and rewards. This App helps a lot with the mathematics. This App consists of small alien figures. The learner is allowed to create his/her own alien character if they participate in the lessons or did well with an activity. They really enjoy this" (Q40).*

Teacher E mentioned:

> *"I use concrete materials such as counters and my ADHD diagnosed learners love working with them. I will also let the learners work in groups with the materials." Furthermore, she mentioned: "If we do multiplication, I will have the learners throw a ball to each other and the learner that catch the ball can ask the next multiplication sum and throw it to the next learner to answer." (Q41)*

iv. One-on-one strategy

According to Teacher B, "*one-on-one strategy*" is a method she uses to ensure the learner keeps up with the work and understands the concepts.

v. Praise method and songs

Teacher C stated:

> *"I use a star system, so if the learner gets something right that he or she finds challenging, I will give them a star and praise them for that." Furthermore, she mentions: "I help them to memorize the steps of multiplication sums by using rhymes or pictures. This is a method that helps them to remember how to complete long and challenging multiplication sums" (Q42).*

vi. Put on the spot method

According to Teachers A and B (Group 1), and Teachers C, D and E (Group 2), frequently asking the learners questions is also a good method. Teacher B stated: *"I try to ask them questions to keep their attention. Some of the learners feel proud if I ask them to give me an answer" (Q43).*

According to Teacher E:

> *"The learners also like it when they mark each other's tests, it's as if it motivates them more to do better. I will also have the learners explain a sum to each other in front of the class" (Q44).*

It was evident during the interviews and observations that the participating teachers used some of the curriculum's strategies, such as concrete materials, repeating methods, and visual methods, for example, pictures and semi-concrete materials. The researcher did, however, notice that the teachers also use their methods, such as praise methods, put-on-the-spot methods, and making use of the learners' bodies.

4.4.4.2 The benefits of the strategies teachers use on the neurodevelopment of learners diagnosed with ADHD.

According to Bakker (2015), the brain of ADHD learners is different from learners not affected by ADHD, and this is also where Greenblatt (2017) mentioned that children identified with ADHD have differently developing brains. Before explaining the benefits of the strategies on the neurodevelopment of the ADHD brain, it is important first to understand the difference between an ADHD brain and a normal functioning brain. Bakker (2015) claims that three parts of the brain can be affected by ADHD: the frontal lobe, temporal lobe, and parietal lobe.

First, the 'frontal lobe' is the part of the brain that helps with attention, organising, and decision-making (Getz, 2013). Greenblatt (2017) mentioned that this part of the brain in ADHD children matures a few years later than in non-ADHD learners. Sheppard (2022) agrees with the authors above and further states that the frontal lobe is also responsible for memory, impulsive control (behaviour), and time perception. As mentioned above, most participating teachers mentioned that the learners in their classrooms struggled with attention and time perception. Secondly, the 'temporal lobe' is also responsible for memory and emotions. According to Sjöwall and Thorell (2022), learners diagnosed with ADHD struggle with emotion regulation, demonstrating behaviours such as aggressiveness, depression, and anger. Furthermore, Sjöwall and Thorell (2022) explain that ADHD learners struggle to control their emotions, and this can be because of a dysfunction in the temporal lobe of the brain. Lastly, the parietal lobe is responsible for intelligence, sensations, and reasoning. According to Greenblatt (2017), children with severe ADHD have lower IQ's and poorer memory. Figure 4.8 below illustrates where the areas in the brain are affected by the disorder ADHD.

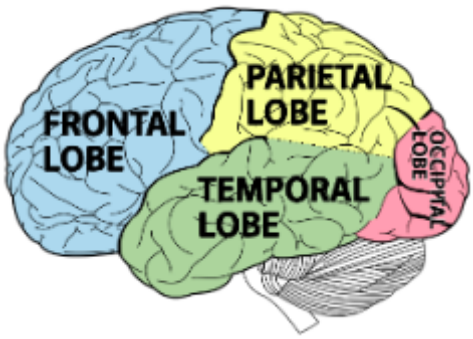


Figure 4.8: Illustration of the affected areas of an ADHD brain

Source (American Academy of Child and Adolescent Psychiatry, 2017)

According to Johnson and Reid (2012), academic difficulties are common among children diagnosed with ADHD. Teachers need to have a working knowledge of the legal rights of ADHD-identified learners and an understanding of their neurodevelopment. ADHD-identified learners often have deficits in working memory (Johnson & Reid, 2012). According to Bornman and Rose (2010), repetition and drill methods are great strategies to help with the neurodevelopment (frontal lobe and parietal lobe) of the ADHD brain. Greenblatt (2017)

agrees with the abovementioned authors and states that ADHD-identified children have smaller brain areas than non-ADHD children. These areas control the child's attention, impulsivity, and executive function. It also controls the child's ability to plan, organise, focus, and their ability to complete tasks. Furthermore, Nel *et al.* (2013) claim that the neurodevelopment of an ADHD brain lags about two to three years behind normal development. Repetition of complex mathematical steps helps with the muscle memory of the brain.

Concrete to abstract learning is also a method that can help the brain to learn and remember, enabling ADHD learners to fully understand the mathematics concepts they are learning. Using concrete, semi-concrete, and abstract learning methods can be related to three kinds of knowledge according to Piaget (physical knowledge, social knowledge, and conceptual knowledge). The first knowledge is physical knowledge, which is the knowledge ADHD learners discover using their senses and manipulating objects. According to all five participants (Teachers A, B, C, D, and E), the use of concrete methods is the most successful. Piaget claims that through play and engagement in mathematics activities that harbour the discovery of ideas, ADHD learners can gain knowledge and better understanding by using their senses (Meier & Naude, 2014).

Teacher D mentioned using "pictures, counting cubes, and the learners' bodies" by letting the learners feel, see, and manipulate objects, whereas Teacher E mentioned that her learners enjoy using "counters". According to Nel et al. (2013), teachers must provide learners with learning disabilities with lots of concrete experiences to help develop their physical knowledge of mathematical concepts, and the classroom environment should lean towards discovery and active participation. Teacher D also mentioned using different textured toys and fidgets to support her learners with emotional dysregulation and hyperactivity.

The second type of knowledge is social. According to Piaget, this knowledge is learned from others. Learners with ADHD gain this knowledge from the teacher when they observe what the teacher does and says. This knowledge fits in with the one-on-one method where the teachers explain examples again through communication and spending more time. As proved by Vygotsky, interaction is vital to an ADHD child's neurodevelopment; therefore, teachers must create opportunities for learners to discuss mathematical ideas with their peers and teacher. This knowledge can be seen in Teacher E's (Group 2) way of teaching when she mentioned: *"I will also have the learners explain a sum to each other in front of the class"*

(Q45).

The third kind of knowledge is conceptual knowledge, which is the more challenging knowledge for learners with ADHD. This knowledge consists of the learner's reflection on what they know, verbalising it, and telling others how they know what they know. This process of learning also utilises worksheets, tests, and doing mathematics in a book without using concrete materials (Meier & Naude, 2014). This means that children use prior knowledge to explore new concepts and ideas. Learners diagnosed with ADHD find this challenging because of their lack of memory and distractibility (Greenblatt, 2017).

Teacher C mentioned that she used a “praise method”. According to Johnson and Reid (2012), praise can be seen as a positive and motivating strategy. This strategy can help stimulate the temporal lobe which is in control of emotions. As mentioned earlier by Greenblatt (2017), ADHD often causes learners to struggle with emotional control, causing them to act impulsively in situations. Therefore, as mentioned by Teachers A (Group 1), C and E (Group 2), it is vital for the teacher to be positive around their learners; otherwise, they will withdraw from the mathematics activities. The praise method will boost and motivate the learners and give them a feeling of achievement.

The above strategies can be linked to the theories mentioned in the research. Piaget’s theory explained the importance of social knowledge linked to assimilation and accommodation. He further explains the importance of the teacher's knowledge in constructing new knowledge in challenging mathematics to support learners identified with ADHD. Social knowledge can only be learned from others. During the research, it was clear that the teachers from the private school (Group 1) did not have enough social knowledge to assimilate and accommodate their ADHD-identified learners with specific mathematics. The teachers from the mainstream school (Group 2) did, however, appear knowledgeable when explaining their methods for teaching difficult mathematics.

Vygotsky’s theory explains how cognitive development occurs through social interaction. During the interviews, the participants mentioned using the one-on-one strategy that could be seen as part of a social interaction with the ADHD-identified learner. Children construct shared meanings through social interactions. Vygotsky further explains that talking aloud becomes silent reflection, converting into an inner conversation and thought. This theory is evident in repetition when the learners practice their tables out loud. Furthermore, Hebb’s theory

explains the importance of the correct classroom atmosphere and settings. According to Hebb's theory, there must be an optimal level of stimulation to learn better. When the stimulation level in the classroom is too low, such as when the learner is drowsy, the child cannot use the sensory information transmitted to the brain. It was evident that some participants did not use this theory because of uncomfortable classroom setups. Hebb's theory also explains how learners' muscle memory can be trained. Teachers using more sensory experiences, such as concrete materials or music, could help set up a neural activity in the ADHD brain. The participating teachers did mention concrete materials but not music.

4.4.5 Curriculum differentiation

According to Davin and Naude (2017), curriculum differentiation is modifying and adapting a curriculum to provide meaningful learning experiences for all learners on different levels of learning. It is also when the curriculum content is adapted in a way as to fit different learning styles and needs. Nel et al. (2017) agree with the authors mentioned above and state that curriculum differentiation is a crucial strategy for responding to the needs of learners with learning barriers and diverse learning styles. Curriculum differentiation includes modifying, changing, adapting, varying, and extending learning and teaching strategies. Furthermore, curriculum differentiation considers the levels of learners' ability to approach the curriculum, their interests, and prior experiences/knowledge. Therefore, it takes place at the level of the curriculum content, the environment where teaching and learning occur, and the strategies and procedures used in teaching and learning mathematics (Davin and Naude, 2017). According to Nel *et al.* (2017) and Pratt (2002), multi-level teaching practices should hold fast to the requirements of curriculum differentiation. Multi-level teaching enables the teacher to develop different lessons with various objects for learners at different capability levels in the classroom. According to Teacher A, the teachers from Group 1 are not allowed to change the curriculum itself, and if so, teachers wouldn't know how. Figure 4.9 illustrates how teachers support learners with diverse learning needs through multi-level teaching and curriculum differentiation.

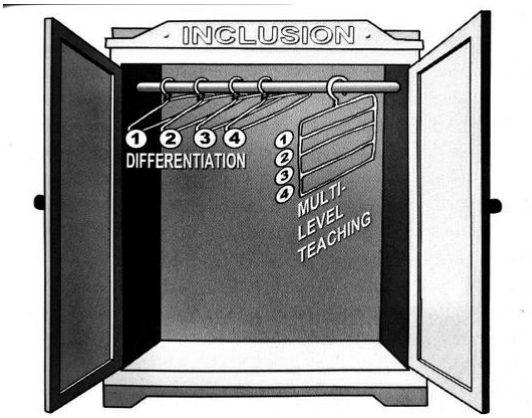


Figure 4.9: Curriculum differentiation

(Source Nel *et al*. 2013)

Figure 4.9 represents each hanger as an individual learner. The hanger with four levels represents the learner with a learning disability (ADHD) that needs more support. In other words, every learner is unique. Every learner can learn a concept, but confident learners need more time, practice, and sometimes one step back.

According to Teacher B, lesson planning can be overwhelming and exhausting and therefore, curriculum differentiation is not always possible for them. Teacher E agreed with Teacher B and further claimed that she experienced a lack of supporting policies, which causes negative attitudes among teachers, and it is not a good attitude among her learners diagnosed with ADHD. There is also a lack of support from education administrators, including the district staff. These staff members should ensure that teachers have enough knowledge strategies to support learners with learning challenges and implement policies (Nel *et al*., 2017 & Pratt, 2002).

Teacher A stated: *"every child is on the same standard" (Q46).*

According to Dreyer (2014), teachers take a one-size-fits-all approach and implement policies for which they are unprepared. Nel *et al*. (2017) agree with Dreyer (2014) and add that teachers who are more knowledgeable about multi-level teaching, learning, and assessment can help supply positive learning experiences for learners with or without ADHD.

4.4.5.1 Caps mathematics assessment policies for Grade 3 learners.

According to the curriculum, assessment is a planned process of recognizing, gathering, and interpreting information about the learners' performances using four assessment steps. These steps are generating and collecting evidence of achievement, evaluating the evidence, recording the findings, and using the information to assist the learner's development and, in helping, improve learners' learning process. Furthermore, assessing learners must be done formally and informally with regular feedback to help improve the learner's learning experience. During an informal assessment, the teacher monitors the learners' progress and makes daily decisions. However, informal assessment is not considered for certification

purposes, and formal assessment tasks are marked and considered by the teacher for progression and certification purposes. Different assessments are appropriate to the skills and concepts needed for different topics at different age groups. Assessment moderation is the process that ensures the assessment is a fair task (DBE, 2016).

According to the mathematics curriculum of South Africa, teachers are encouraged to conduct a baseline assessment in the first term. The learners' results in the baseline assessment should not be used to label their ability. This assessment should be used to understand how activities can be changed to give more attention to challenging aspects. Formal mathematics assessments include different topics. Numbers, Operations, and Relationships comprise sixty per cent of the mathematics in Grade 3. Recording is the process where the teacher writes down a learner's performance level in a specific assessment task. The recordings must give evidence of the conceptual progress of the learner and readiness for the next grade. Records of learners' performance should be used to verify the progress of the teacher and the learner in the teaching and learning mathematics. According to the curriculum, teachers must report grades in percentages. Figure 4.10 below is an example of the codes and percentages from the South African Curriculum.

Rating code	Description of competence	Percentage
7	Outstanding achievement	80 - 100
6	Meritorious achievement	70 - 79
5	Substantial achievement	60 - 69
4	Adequate achievement	50 - 59
3	Moderate achievement	40 - 49
2	Elementary achievement	30 - 39
1	Not achieved	0 - 29

Figure 4.10: Codes and percentages for recording and reporting mathematics

Source (Curriculum)

According to the curriculum, Grade 3 learners must be able to do the following multiplication mathematics: count pictures of grouped objects, order and compare numbers up to 500, read and write numbers 0-1000, doubling and halving, number patterns with multiplication, count forward and backwards in 2's up to 500, calculations about doubling and halving, number

patterns, number concepts, solve problems, and calculations (doubling). The moderate achievement level for Grade 3 learners in mathematics in South Africa is Level 3 (40%-49%) (Dreyer, 2014). Participating teachers from Group 1 and Group 2 claimed that the learners diagnosed with ADHD usually struggle with concepts, order, comparing, reading and writing of numbers, patterns, multiplication from numbers 8 and up, halving, and solving problems. These challenges are caused by the learner's hyperactivity, inattention, and poor concentration. The teachers felt that some of the concepts were too difficult for the ADHD-identified learners and that it was unfair to assess them in the same way as typically developing learners. This proves that the curriculum was created for the typical developmental age of learners and not necessarily for learners diagnosed with any disability.

4.4.5.2 The teachers' views on the effectiveness of the Curriculum for .ADHD-diagnosed learners and what to add or remove

The curriculum aims to ensure that children apply knowledge and skills in ways that are meaningful to their lives. It also equips the learners with the necessary knowledge, skills, and values regardless of their physical or intellectual ability. Furthermore, according to the curriculum, learners who experience barriers in mathematics must be exposed to activity-based learning. Teachers must use practical examples and concrete materials more often than with other learners. Dreyer (2014) states that moving to abstract work too soon might lead to learner frustration and regression.

Teacher A stated that the curriculum does not allow enough opportunities for concrete materials. Teacher B agreed with Teacher A and stated:

> *"I think that the National Curriculum Statement is too difficult for our ADHD-identified learners, if they made it a bit easier and simple it might have been more sufficient" (Q47).*

Furthermore, Teacher C mentioned: *"for the ADHD-diagnosed learners, the curriculum can be difficult, and they need more one-on-one time to understand and complete the mathematics" (Q48).*

Davin and Naude (2017) mention that according to the curriculum, these learners may and should require and be granted more time to complete assessment activities, tasks, and thinking skills. The number of activities should be adapted to the learner without compromising the concept and skills addressed (Davin & Naude, 2017).

Teacher D stated:

> *"On the one side, yes, but on the other side, there is ADHD diagnosed learners that find the curriculum very difficult. They feel overwhelmed because of information being overloaded. But I do have one ADHD diagnosed learner who finds it easy, so I think it depends on the learner's ability and capacity" (Q49).*

Teacher E mentioned: "*Yes, I do think so. My learners do not find the curriculum work too difficult" (Q50).*

Teacher A claimed that the curriculum keeps "hammering" that they must do mental mathematics in Grade 3. She stated:

> *"With my understanding they are supposed to use physical aids until they are at least going to High School. I think that some of the work is too difficult for learners diagnosed with ADHD" (Q51).*

According to the curriculum, teachers should never force learners to do mental calculations with which they struggle. Writing materials or counters should always be available for those learners who may need them. However, the work in the curriculum is developed at the "typical" developmental age of learners in different grades. For example, the typical age of Grade 3 is nine, so the curriculum's knowledge, concepts, and skills are developed according to the typical chronological and emotional development of the nine-year-old child and not necessarily the nine-year-old child diagnosed with ADHD (Nel *et al.,* 2017). According to the participating teachers, poor cognitive ability, cluttered classrooms, and inappropriate subject materials such as "too difficult" work is not very effective for the learners diagnosed with ADHD. Teacher E mentioned that she would want to remove some of the worksheets and materials that are too busy or "boring", and sometimes confusing for her ADHD-identified learners, for example, the mathematics books from the Department of Education. She stated: *"The learners do not enjoy the books from the Department, the methods in the books of the Department differ from the methods that we use, so it confuses them" (Q52).*

Furthermore, Teacher E mentioned she would rather set up worksheets with the same concept and only ask simpler questions with more pictorial examples and give extra time for the learner if he or she wants to work out the answer concretely.

4.4.5.3 Teachers' views about assessing children with learning disorders compared to typically developing children.

According to Teacher A:

> *"We have to assess them the same way because everybody is writing a specific test that is on the same standard. You can, however, explain a certain concept to them again, but you are not allowed to help them with the answers" (Q53).*

Teacher B stated:

> *"We are not allowed to adjust the assessment all the learners are assessed in the same way. However, the only advantage the ADHD diagnosed learners get is more time to complete challenging mathematics" (Q54).*

Teacher C mentioned: "*We are not really allowed to adjust the assessment; otherwise, it might be difficult to find the areas where the child struggles in his/her mathematics" (Q55).*

Teacher D and Teacher E also mentioned that they are not allowed to adjust assessments. However, they can give the learner extra time and more explanations. According to the White Paper 6 policy, assessment diversity should be accommodated. This diversity will be ensured through a flexible curriculum and assessment policy. However, a few issues arise from various parts of the curriculum. This includes the content of learning programs, the language and medium of learning and teaching, the organisation of classrooms, teaching styles and pace, time frames for completion of tasks, availability of concrete materials and equipment, and assessment methods.

Teacher A stated: "*so, from the District I do not think there is any support there" (Q56).*

Correspondingly to the White Paper 6 policy, the critical responsibility of the district support teams is to provide curriculum, assessment, and instructional support to schools in the form of illustrative learning programmes, learning support materials, and assessment instruments. According to White Paper 6, assessment processes will address barriers to learning, and current policies and practices will also be reviewed to ensure that the needs of all learners are recognised and addressed. However, Davin and Naude (2017) state that despite the radical transformation of education in South Africa, the assessment practices in most private and mainstream schools are still the same. Furthermore, the authors claim that though the

policies such as the Department of Basic Education's National curriculum statement (General Education and Training Assessment guidelines for Foundation Phase Grade R-3) give detailed outlines about what is expected from teachers, teachers still find it hard to implement the theory in real life in the classroom. Maringe and Prew (2015) agree with Davin and Naude (2017) and add that learners are not exposed to various assessment practices, and the old paradigms still govern assessment practices.

The participating teachers from Group 1 and Group 2 find it challenging to assess their ADHD-identified learners compared to typically developed learners, especially regarding concepts with which the ADHD learners struggle. The learners identified with ADHD need more time, explanations, examples, and sometimes different setup worksheets, tests, or activities. It depends on the severity of the ADHD diagnosis. The participating teachers claim that different activities and tests should be set up inclusively for struggling learners. It must still involve the same concepts and marks; the questions can just be set differently. But as observed from the interviews and mathematics books, it was clear that the teachers did not know how to set the questions on the worksheets differently. The teachers lack knowledge of supporting learners with ADHD in their classrooms.

4.5 SUMMARY

In Chapter 4, the research presented the findings per the themes that emerged from analysing the data across all data sets. The researcher contemplates the research to be trustworthy and feels confident that the research will enable her to answer the research questions mentioned in Chapter 1. According to the researcher, she has presented her research findings thoroughly and unambiguously, persisting in the strategies she had set for systematic data analysis. The research was presented in the 'third person format', supported by quotes from the structured interviews and quotes from other research studies correlating to the responses from the participating teachers and observations. The researcher also provided photographs of the observations made. In the next chapter, Chapter 5, the researcher will discuss the research study's findings, conclusions, and recommendations.

5 CHAPTER 5: INTERPRETATION OF RESEARCH FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

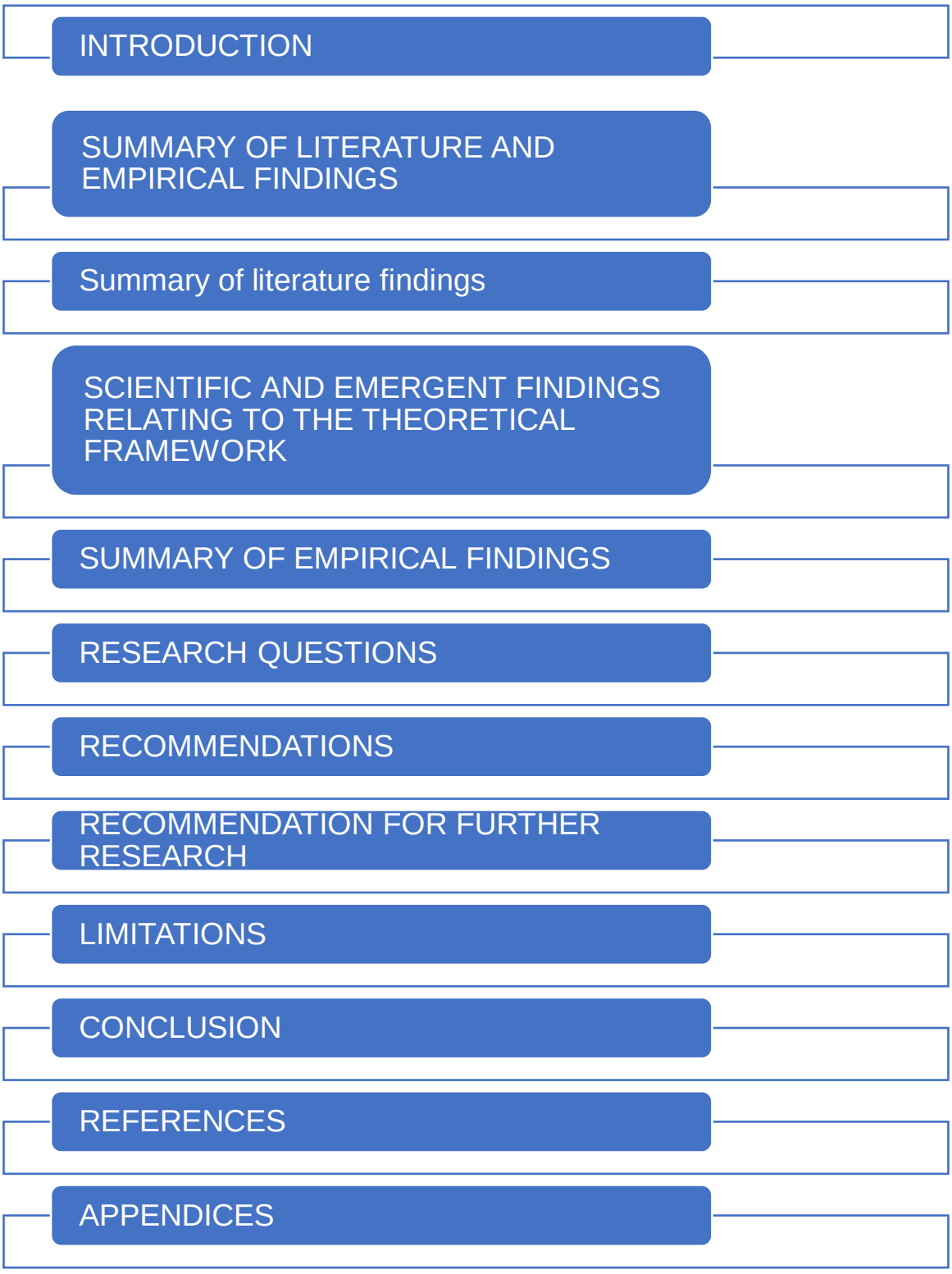


Figure 5.1: Outline of Chapter 5

5.1 INTRODUCTION

Chapter 4 presented descriptions of the participants, data analyses and emerging themes, and the research findings. Quotes and responses from the participants were presented and discussed with references from previous studies.

Chapter 5 elucidates the research findings in connection with relevant and imperative literature on teachers' conceptualisation of ADHD, neurodevelopment, and mathematical interventions in Grade 3 Foundation Phase classes. The study's theoretical frameworks, namely Piaget's neuroplasticity theory, Vygotsky's sociocultural theory, and Donald Olding Hebb's neurophysiological theory, provided an identifiable background against which the findings can be interpreted and explained. Furthermore, Chapter 5 referred to and endeavoured to answer the study's research questions mentioned in Chapter 1.

5.2 OVERVIEW OF THE PREVIOUS CHAPTERS

In this overview, the researcher summarised the research study by providing a brief synopsis of the five chapters, illustrating the important issues that were significant to the study. This overview also served as a background to the research's findings, recommendations, limitations, and conclusions.

CHAPTER 1

Chapter 1 introduced the study. This chapter provided the rationale, purpose of the study, research questions, and working assumptions. The chapter then outlined the literature review, embedded within Piaget's neuroplasticity theory, Vygotsky's sociocultural theory, and Hebb's predominantly neurophysiological theory as the conceptual framework. In addition, an outline of the epistemology and methodological paradigm was presented, as well as the ethical considerations, trustworthiness, and concluding remarks.

CHAPTER 2

Chapter 2 explored the literature review within the conceptual framework. The chapter first introduced scholarly literature about the conceptualisation of the concepts of ADHD and neurodevelopment and the different conceptualisations from an international, African, and South African perspective. From the literature review, it became evident that the conceptualisation of ADHD neurodevelopment is differently understood from different contexts. Furthermore, the chapter mentioned how dyscalculia could be understood from an

ADHD context. The chapter then provided an overview of the conceptual framework that underpinned the study. From the literature, it became apparent that teachers in the South African context do not know enough about ADHD neurodevelopment and how to differentiate the curriculum to make inclusive teaching easier for ADHD-identified learners. However, the education systems internationally and in South Africa are committed to ensuring that typically developing learners and learners with learning disabilities have access to quality education. The results of the literature reviewed revealed that teachers in South Africa do not have enough support from school management teams, DBE, and DBST to help them gain more knowledge about ADHD or any other learning disability. There is also a lack of funding to ensure the effectiveness of inclusive teaching. The literature also explored the importance of teachers' understanding of ADHD neurodevelopment to help with mathematics interventions.

CHAPTER 3

In Chapter 3, the methodology and research design were discussed as they form the foundation of the study. The chapter further provided a detailed discussion of the research paradigm. Furthermore, the research methods, the role of the researcher, the research sites, and the research participants were discussed in detail. Using a qualitative method framed within the interpretive paradigm enabled the researcher to hear the "true self" answers from the participating teacher. This research approach helped the researcher to understand the participating teacher's knowledge and experiences of the phenomenon under study. The principle of trustworthiness of this study was mentioned and discussed. This chapter concluded by justifying the research methodology in line with the research questions and objectives.

CHAPTER 4

In Chapter 4, the empirical results collected from the field notes and observations were analysed and interpreted. By presenting data in this chapter, the researcher considered the literature reviewed and the study's conceptual framework. This chapter began by mentioning the research questions again and with the presentation, analysis, and interpretation of the participating teacher's biographical data. This data were presented by individual case studies from interviews and observations within a mainstream and private school. The data were divided into five themes with categories. The themes identified were teachers' conceptualisation of neurodevelopment and the ADHD disorder, teachers' perspectives about ADHD neurodevelopment and the mathematical interventions in the Foundation Phase, the support teachers receive, inclusive strategies used to help learners diagnosed with ADHD, and curriculum differentiation. Discussion in this chapter also included verbatim participant

quotations during the interviews. Some participants, particularly the Afrikaans-speaking participants, preferred to express themselves in their mother language, and the researcher further translated into English for better clarification. However, only three teachers preferred to respond in Afrikaans, therefore, the meaning was not lost in translation as the researcher herself is an Afrikaans home language speaker.

5.3 SUMMARY OF LITERATURE AND EMPIRICAL FINDINGS

This section summarises the literature findings discussed in Chapters 2 and 3. This section also summarises the empirical findings that appear in Chapter 5.

5.3.1 Summary of literature findings

The aim of interpreting the literature findings was to obtain links between the research findings, the themes, and the sub-themes that emerged from data analysis. The utility of the theoretical frameworks was linked to the study's research findings. The interpretation of the research was also a discussion aimed at confirming the existing literature with a comparison to new insights of the study. The interpretation of the research findings needed a reference to the themes and sub-themes from Chapter 4. The themes and sub-themes enabled the organisation thereof. Table 5.1 below illustrates the interpretation of the research findings structured from the themes, sub-themes, and their relevance to the research sub-questions from the study.

Table 5.1: Illustration of the interpretation of research findings structured from the themes, sub-themes, and their relevance to the research questions.

Themes	Sub-themes	Relevance to primary, secondary, and sub-research questions
Theme 1: Teachers' conceptualisation of neurodevelopment and ADHD	**Sub-theme 1.1:** Teachers understanding of the terms neurodevelopment and ADHD **Sub-theme 1.2:** The importance of neurodevelopment in respect of ADHD. **Sub-theme 1.3** Impact of ADHD on learners' cognitive development and learning.	**Primary research question** How do Grade 3 FP teachers in mainstream and private schools conceptualise ADHD and mathematics access?
Theme 2:	**Sub-theme 2.1**:	**Secondary research question (sub-question 1)**

Themes	Sub-themes	Relevance to primary, secondary, and sub-research questions
Teachers' perspectives about ADHD neurodevelopment and the mathematical interventions in the Foundation Phase.	Mathematics interventions aligned with the Curriculum. **Sub-theme 2.2:** Grade 3 teachers' perspectives about mathematics interventions for learners diagnosed with ADHD in the Foundation Phase. **Sub-theme 2.3:** Challenges participants face in implementing the mathematics interventions.	What are teachers' perspectives on ADHD, neurodevelopment, and mathematics interventions in the Grade 3 Foundation Phase?
Theme 3: The support teachers receive	**Sub-theme 3.1**: Types of support teachers receive from the school. **Sub-theme 3.2:** Types of support teachers receive from the DBE	**Secondary research question (sub-question 2)** What kind of support do teachers in mainstream and private schools receive to enhance mathematics access for learners diagnosed with ADHD?
Theme 4: Inclusive strategies used to help learners diagnosed with ADHD	**Sub-theme 4.1:** Strategies and methods participating teachers used to make challenging mathematics easier for learners diagnosed with ADHD **Sub-theme 4.2:** The benefits of the strategies teachers use on the neurodevelopment of learners diagnosed with ADHD.	**Secondary research question (sub-question 3)** Which inclusive strategies do teachers in mainstream and private schools use that influence learners identified with ADHD with mathematics challenges?
Theme 5: Curriculum differentiation	**Sub-theme 5.1:** Caps mathematics assessments policies for Grade 3 learners. **Sub-theme 5.2** The teacher's views on the effectiveness of the Curriculum for ADHD diagnosed learners and what to add or remove.	**Secondary research question** What are teachers' perspectives on ADHD, neurodevelopment and mathematics interventions in the Grade 3 Foundation Phase?

Themes	Sub-themes	Relevance to primary, secondary, and sub-research questions
	Sub-theme 5.3: Teachers' views about assessing children with learning disorders compared to typically developing children.	What kind of support do teachers in mainstream and private schools receive to enhance mathematics access for learners diagnosed with ADHD? Which inclusive strategies do teachers in mainstream and private schools use that influence learners identified with ADHD with mathematics challenges?

Table 6.1 enabled an interpretation of findings based on the themes and sub-themes from Chapter 4. The column named "**Relevance to primary, secondary, and sub-research questions"** illustrates a connection between the themes, sub-themes, and the study's research questions. This, therefore, insinuates a connection between the interpretation of the research findings and the research questions. Table 6.1 provided credibility when answering the study's research question. The section below provides responses to the research primary, secondary and sub-questions.

5.3.2 Teachers' conceptualisation of neurodevelopment and ADHD relevant to the primary research question

During the interviews, it was evident that the participating teachers had little conceptualisation about the neurodevelopment of ADHD-identified learners. The responses also revealed that most teachers found the term neurodevelopment compared to ADHD interesting and wanted to know more about it. The teachers wanted to know more because they were not equipped with enough knowledge, including knowledge of materials and support available for ADHD-identified learners. The lack of knowledge about the neurodevelopment of ADHD-identified learners leads to less emotional closeness between the teacher and the learner.

5.3.2.1 Teachers' understanding of the term neurodevelopment and ADHD.

From the data analysis Theme 1, Sub-theme 1.1, it was evident that teachers had a narrow understanding of the neurodevelopment of ADHD. A recurring response from all the participants was that they thought it had something to do with the brain. The teachers' understanding of ADHD neurodevelopment gave credence to the statements of Donald *et al.* (2014:311), Nel *et al*. (2013:7), and Makoelle (2016), who noted that "most teachers do not have enough knowledge about the neurodevelopment of ADHD" (see Chapter 4: 111-112). It also came to light that the teachers only knew the basic symptoms of ADHD, such as hyperactivity and distractibility, but not enough to support these learners fully. A recurring response from the participating teachers understanding of ADHD was that learners struggle to concentrate and take longer to understand difficult concepts. Only one teacher mentioned that neurodevelopment is the study of the brain that have a connection with ADHD, but she could not elaborate further on that.

5.3.2.2 The importance of neurodevelopment in respect of ADHD.

It was evident that the teachers did not have enough knowledge about the importance of the ADHD neurodevelopment. This statement hinges on the response of one of the participating teachers that mentioned she believed teachers must be made more aware of the importance of neurodevelopment of learners with learning barriers (see Chapter 4, page 112-113). It also collaborated with the responses from the other teachers, who confirmed that they had never heard of the term before. It was also evident that not all teachers have enough understanding about ADHD neurodevelopment, as seen from the responses of one of the participants who read her answers from her computer. The teacher who read the answers from her computer mentioned definitions of ADHD and neurodevelopment that she had copied from the internet.

5.3.2.3 Impact of ADHD on learners' cognitive development and learning.

During the interviews, all five participating teachers had different responses about the impact of ADHD on learners' cognitive development and learning. However, it was evident that some of the participating teachers did not really understand the impact of ADHD on learners' cognitive development and, therefore, could not answer the question asked. This finding underpins the statement of Sternberg and Sternberg (2012) that not a lot of people understand the impact of ADHD on the brain functioning of a person. However, cognitive neuropsychologists have learned a great deal about the attentional processes in the brain; therefore, important points can be passed on to teachers when studying education, or special courses about ADHD can be held for teachers more often.

5.3.3 Teachers' perspectives about ADHD neurodevelopment and the mathematical interventions in the Foundation Phase

The data analysis in Chapter 4, Theme 2, showed that teachers did not feel comfortable with mathematics interventions because of the lack of resources and materials. This finding supports the statement of David (2020) mentioning more resources are necessary for developing training programmes that would prepare and equip teachers to provide better interventions for learners with learning disabilities such as ADHD.

5.3.3.1 Mathematics interventions aligned with the Curriculum.

The researcher examined the teachers' knowledge of the mathematics interventions for learners diagnosed with ADHD mentioned in the curriculum. It was clear that some participants did not have a thorough knowledge of the interventions suggested by the curriculum. This was evident when one of the participants mentioned that according to the curriculum, Grade 3 learners are not allowed to use concrete materials all the time (see Chapter 4). The curriculum clearly states teachers must use concrete helping aids, pictures, and supporting materials to help teach learners with severe ADHD process mathematics problems. To my dismay, not all teachers were aware or trained to differentiate the curriculum content for easy access to ADHD learners.

5.3.3.2 Grade 3 teachers' perspectives about mathematics interventions for learners diagnosed with ADHD in the Foundation Phase.

During the interviews, the teachers were allowed to give their perspectives about the mathematics interventions they use in their Grade 3 classrooms. Most participating teachers understood what interventions to use for their ADHD-identified learners. However, some participants felt negative about specific interventions mentioned in the curriculum because of constrained time and finances. Several times in the interviews, the teachers mentioned that the interventions in the curriculum were not always practical for the cohort of ADHD learners in their classrooms. They further explained that regardless of the availability of concrete materials, the ADHD learners mostly just needed more one-on-one time, which was impossible in a classroom with diverse learners with different abilities.

5.3.3.3 Challenges teachers face in implementing mathematics interventions.

Responding to challenges associated with implementing mathematics interventions, the teachers noted that difficult, time-consuming and boring activities, hyperactivity and distractibility, and the challenging emotions of the learners, posed a challenge to the teaching and learning of difficult mathematics. To my dismay, teachers do not understand the neurodevelopment of the learners and therefore find the learners' behaviours challenging.

5.3.4 The support teachers receive

The teachers from Group 1 reported receiving little support from the school management regarding ADHD mathematics interventions. The above includes the complete absence of support from the South African Education Districts Support teams, including the DBE, for lesson planning and classroom management. On the other hand, the teachers from Group 2's reasoning was different. According to Group 2, they received some support from the DBE and a lot of support from the school management teams. Their responses are listed in the sections below.

5.3.4.1 Types of support teachers receive from the school.

During the study, it was evident that the teachers from Group 1 (private school) received less support than Group 2 (mainstream school). Group 1 noted that they had to buy most of the materials with their own finances. They mentioned that their classrooms were very small and completely unsuitable for learners with ADHD. The classrooms were double stories, and the teachers had to walk through each other's classrooms if they needed to go somewhere. The infrastructural design added disturbances to the already compromised attention issues. The teachers from Group 1 also noted that they did not receive many workshops to enhance their knowledge capacity. According to my awareness, private schools must be particularly suited to support learners with barriers in all aspects. Because parents pay more money for their children to attend a private school, they expect them to receive more support for disabilities.

The teachers from Group 2 also frowned upon inadequate classroom space. However, they did not have a problem with the support they received from the school. The teachers mentioned that they frequently get asked about the training they need, the school provides concrete materials, and they also get a lot of support from their principal of academics. It was evident that the teachers from Group 2 also find time for training programs challenging.

5.3.4.2 Types of support teachers receive from the DBE.

The teachers from Group 1 stated that they do not receive much support from the DBE. On the other hand, Group 2 mentioned that they get support and guidance from the DBE, but it was not always helpful. Group 2 noted that the training they received from the DBE was not appropriate for learners diagnosed with ADHD. The teachers stated that the programmes were too boring or too difficult. During the study it was evident that teachers in general, do not receive enough support from the DBE and that the DBE does not make enough time and effort to equip the teachers to understand the requirements of learners with learning barriers better.

5.3.5 Inclusive strategies used to help learners diagnosed with ADHD

During the study, it was discovered that the teachers from the private school and mainstream school had some knowledge about strategies to help learners diagnosed with ADHD. However, their lack of knowledge about the neurodevelopment of ADHD learners made it challenging to implement these strategies according to their developmental levels.

5.3.5.1 Strategies and methods participating teachers used to make challenging mathematics easier for learners diagnosed with ADHD.

It was clear that the teachers in Group 1 and Group 2 used the same strategies; however, the difference was that the teachers from Group 2 used more concrete materials because the school management teams supplied them with the resources. The teachers from Group 1 had to share their materials. Sharing contributed to broken and lost materials. There were common strategies/practices from Group 1 and Group 2, such as the repeating method, concrete materials, and the one-on-one strategy. It was revealing that the teachers did not mention any strategies or methods to support the learners with their emotional challenges. However, one teacher mentioned she used textural toys that helped calm her learners. Many participants mentioned that although they use the methods described, but the learners' behaviour remains challenging on certain days. The above supports the researcher's assumption that understanding the neurodevelopment of ADHD learners is crucial to offer appropriate foundation for learning and teaching and to set the appropriate arousal level, as mentioned in Chapter 2.

5.3.5.2 The benefits of the strategies teachers use for the neurodevelopment of learners diagnosed with ADHD.

The study revealed that the teachers did not understand the concept of neurodevelopment. Chapter 4 showed that some teachers mentioned they had never heard of the term before. The participating teachers did, however, understand that concrete materials are an important strategy and a useful component for learners with learning barriers. It was evident that some teachers knew how to support the learners when they felt stressed. As mentioned earlier, one of the participants from Group 2 used soft toys to calm her learners.

5.3.6 Curriculum differentiation

Curriculum differentiation indicates the modification and adaption of a curriculum to provide quality learning experiences for learners experiencing learning barriers. Teachers, however, do not understand how to adapt the curriculum to make difficult concepts easier to process for learners with ADHD. During the interviews and observations, it was not obvious how the teachers adapted certain mathematical concepts from the curriculum to make learning

memorable. While the researcher observed the mathematical books and worksheets, no adaptions were visible; the severe ADHD learners had the same workbooks and assessment exercises as the learners experiencing no barriers. All learners were exposed to the same texts and expected to complete them in the same allocated time. The researcher could not observe any preferences from the ADHD learner's side. The negligence of the teachers' understanding of the impact of difficult work in the curriculum can worsen the learning process of ADHD learners and make teaching and achievement of outcomes more difficult for the learners and teacher. All five participants had the same response and responded with a "no" when the researcher asked if they made special adaptions during a test and difficult mathematics worksheets for ADHD-identified learners.

5.3.6.1 CAPS mathematics assessments policies for Grade 3 learners.

The teachers vaguely understood the assessment policies for Grade 3 learners; it was also not visible whether they understood how to adapt the assessment for learners with severe ADHD that struggle with hyperactivity, distractibility, and emotional regulation. During the interviews and observations, it was clear that all five participants assessed their learners the same. The only advantage the learners with ADHD get is more time.

5.3.6.2 The teachers' views on the effectiveness of the Curriculum for ADHD-diagnosed learners and what to add or remove.

The teachers mentioned that they use the work in the curriculum because it provides them with a measurable plan and structure for educating the learners. Therefore, the researcher will refer to the curriculum. The curriculum states that teachers must use practical examples with concrete materials for a longer period for learners with learning barriers. The teachers interviewed from Group 1 and Group 2 explained that the curriculum is too difficult for ADHD learners. The participating teachers claim that there was not enough time to support the learners fully, and the work was overwhelming for them. However, Teacher E from Group 2 disagreed. She stated that the work is not too difficult for her learners. The researcher noticed she was one of the participants with the most concrete materials in her classroom and one of the teachers with the calmest personality. The participant, however, mentioned that there were activities in the curriculum that she felt were unnecessary. She claimed some materials were too dull and might overwhelm the learners. Her submission supports the notion that teachers need to be intentional when choosing support materials and understand the developmental levels of ADHD learners in their classrooms.

5.3.6.3 Teachers' views about assessing children with learning disorders compared to typically developing learners

It was clear that all five participants had the same view on assessing learners with learning disorders. They claimed that learners with or without barriers must be assessed the same, according to the curriculum specification. It was visible from the mathematics books that the ADHD learners had no adaption made in their tests or worksheets. It appeared as if the teachers didn't understand how to make the adjustments in assessment activities or worksheets, or they thought they were not allowed to make adjustments.

5.4 SCIENTIFIC AND EMERGENT FINDINGS RELATING TO THE CONCEPTUAL FRAMEWORK EMBEDDED IN MANY THEORIES

5.4.1 Piaget's neuroplasticity theory

This study used Piaget's theory to understand the neurodevelopment of ADHD-identified learners. Piaget mentioned that educational experiences for children must be built around the child's cognitive structure. Piaget's theory was also used to help explain how the brain of ADHD learners can be trained and exercised to process mathematical problems and make the teaching easier. According to Piaget's neuroplasticity theory, the intellectual development of each learner unfolds in different ways at different stages. However, the development of each child is based on the interaction between the child and the environment (Tapia, 2012). As mentioned in Chapter 2, the researcher believes that Piaget's theory will help teachers better understand the neurodevelopment of ADHD learners and how to exercise the brain to improve mathematics conceptualisation. This insight was achieved by using Piaget's statement that teachers must know the level of functioning of each (ADHD) learner's cognitive structure and create an educational environment (safe classroom) that generates opportunities for discoveries (Hergenhahn & Olson, 2012).

During the semi-structured interviews, it was clear to the researcher that certain participating teachers did not understand the neurodevelopment occurring for learners diagnosed with ADHD. The study shows the effect training could have on a learner diagnosed with ADHD and why it can alleviate the challenges in teaching and learning mathematics for learners with ADHD. Before understanding the emergent findings relating to Piaget's neuroplasticity theory, one should first consider Piaget's four different stages of development. According to Tapia (2012) and Donald *et al.* (2010:49) Piaget's theory consists of the following four stages: "the sensorimotor stage, preoperational stage, concrete operation stage, and the formal operation stage".

During the first stage (birth to 1.5 years), the sensorimotor stage, children learn through experiencing and integrating sensory input through their movement, coordination, and imitation (Tapia, 2012). According to Sternberg and Sternberg's (2012) studies, some learners are born with genetic ADHD. The researcher found that only a few teachers understand that ADHD could be a brain dysfunction. Therefore, ADHD symptoms can be beyond the learner's control when they find certain mathematics concepts more difficult than typically developed learners. Symptoms such as distraction, hyperactivity, and emotional dysregulation can be innocent but can be managed if the teachers are knowledgeable about ADHD. The second stage, the preoperational stage (1.5 years to 7 years), mentions the development of motor movement and mobility skills of children. This stage includes improving many mental skills that impact the child's actions (Tapia, 2012). Sternberg and Sternberg's (2012) studies have shown that learners with ADHD exhibit slower understanding and vary in reaction times.

Batka and Deventer (2013) and Greenblatt (2017) argue that ADHD influences the frontal lobes of the brain. The frontal lobes regulate complex mental activities and behaviours. Piaget reiterates that the second stage (preoperational stage) plays an important role in a child's motor development. Batka and Deventer (2013) explain that ADHD causes a dysfunction in the frontal lobes that can influence the control of motor movement, memory, and the production of speech of a learner. During the interviews, the participating teachers mentioned several times that the ADHD-identified learners in their classroom struggle with memory, uncoordinated movements, and concentration. These symptoms are all side effects of the affected part of the frontal lobes of the brain. Although the participating teachers could name the symptoms, such as loss of concentration, hyperactivity, and memory challenges, they still did not really understand what and how they were caused. Furthermore, Greenblatt (2017) mentions that these parts of the brain can be stimulated with exercises such as drill methods and mindfulness meditation skill. This skill can help with self-regulation, control inattentiveness, and decrease hyperactivity and impulsivity.

The participating teachers mentioned using rewards and uplifting motivational words to support and motivate their learners. These statements fit with Leaf's (2013) statement, where he mentioned that teachers must engage learners at their level of understanding to teach mathematics more effectively and use positive words. The third stage, the concrete operations stage (11 years and onward), includes the logical thinking of children about specific concrete events. During this stage, the child also understands that a person can mentally hold more

than one thought simultaneously. According to Tapia (2012), children gain the mental skills to understand other people's perspectives and that people's perspectives can differ from each other. The fourth stage includes the formal operation stage. This is where children gain the ability to think abstractly and make conclusions from information. During the semi-structured interviews and observations, the researcher realised that the teachers used concrete materials to help learners remember and understand how to hold more than one thought at a time when doing mathematics. However, as Piaget's fourth stage mentions, children begin to learn to think abstractly at the ages of 11 years and onwards, whereas it was clear to the researcher that some of the participating teachers used more than necessary abstract materials. Many abstract materials can demotivate learners and cause many mathematical challenges. It was also clear that most of the worksheets and methods the teachers used were not "concrete" enough but rather too "abstract". The researcher agrees with Piaget's theory that learners are more ready for abstract work and materials at the age of 11 years (Grade 5).

The practice can be more challenging for learners diagnosed with ADHD because, according to Greenblatt (2017), the development of learners with ADHD lags two to three years behind compared to typically developing learners. For the researcher it was clear that the teachers being interviewed did not understand the importance of the neurodevelopment of an ADHD brain well enough to realise that concrete materials are essential still at the age of 9 years (Grade 3). The worksheets appeared as if they made little time for concrete work when doing mathematics, and to get all the mathematics done in time, most of the work is more abstract. The researcher realised that the teachers from Group 1 (private school) thought it was better and faster if learners worked abstractly, forgetting the information processing challenges for these learners. According to Krüger *et al.* (2016), ADHD learners must work concretely until the concept is fully grasped and internalised. Several times the teachers mentioned to the researcher that they did not have enough time for a lot of concrete work. This time pressure can overwhelm learners and teachers with little teaching and learning happening in the process.

As mentioned in Chapter 2, Piaget's theory also included the assimilation and accommodation in a situation. According to Krüger *et al*. (2016), Piaget's ideas of assimilation and accommodation can help learners with mathematics challenges through constructivism. Assimilation takes place when new information is taught that can fit into a child's existing map. During the interviews, the researcher noticed that because of teachers' time pressure, they

could not always wait until the information fits into the learner's existing map before proceeding. Therefore, the teachers taught new information (mathematics) even though the learner had not yet fully grasped the previous concept (mathematics). This time pressure became problematic for learners diagnosed with ADHD (Getz, 2013). According to Getz (2013), dopamine is reduced in the brain of learners with ADHD. This reduced dopamine level also influences those learners' frontal lobes, causing poor decision-making, lack of planning, inattention, and hyperactivity. The researcher believes that because of this challenge, ADHD-identified learners already experience these disadvantages. It is unfair to force these learners to learn new work if they have not thoroughly understood the previous work.

Piaget also spoke about the accommodation occurring when new information arises, contradicting the child's existing map. For example, the Grade 3 learner may learn about times tables in a different pattern than they were used to in the past. The teacher now has to use disequilibrium to help the brain restore concepts. During the interviews, the researcher realised that teachers do not always have time to "go back and restore learned concepts" Therefore, they ignore that the child struggles and move on to new concepts. The researcher believes that Piaget's theory can help teachers understand the neurodevelopment of ADHD learners and how to exercise the brain to improve in mathematics conceptualisation, and how important it is to help restore concepts when new concepts are being taught. Figure 5.2 below gives an example of the representation of Piaget's ideas compared to the problems the researcher found during the interviews with the participating teachers.

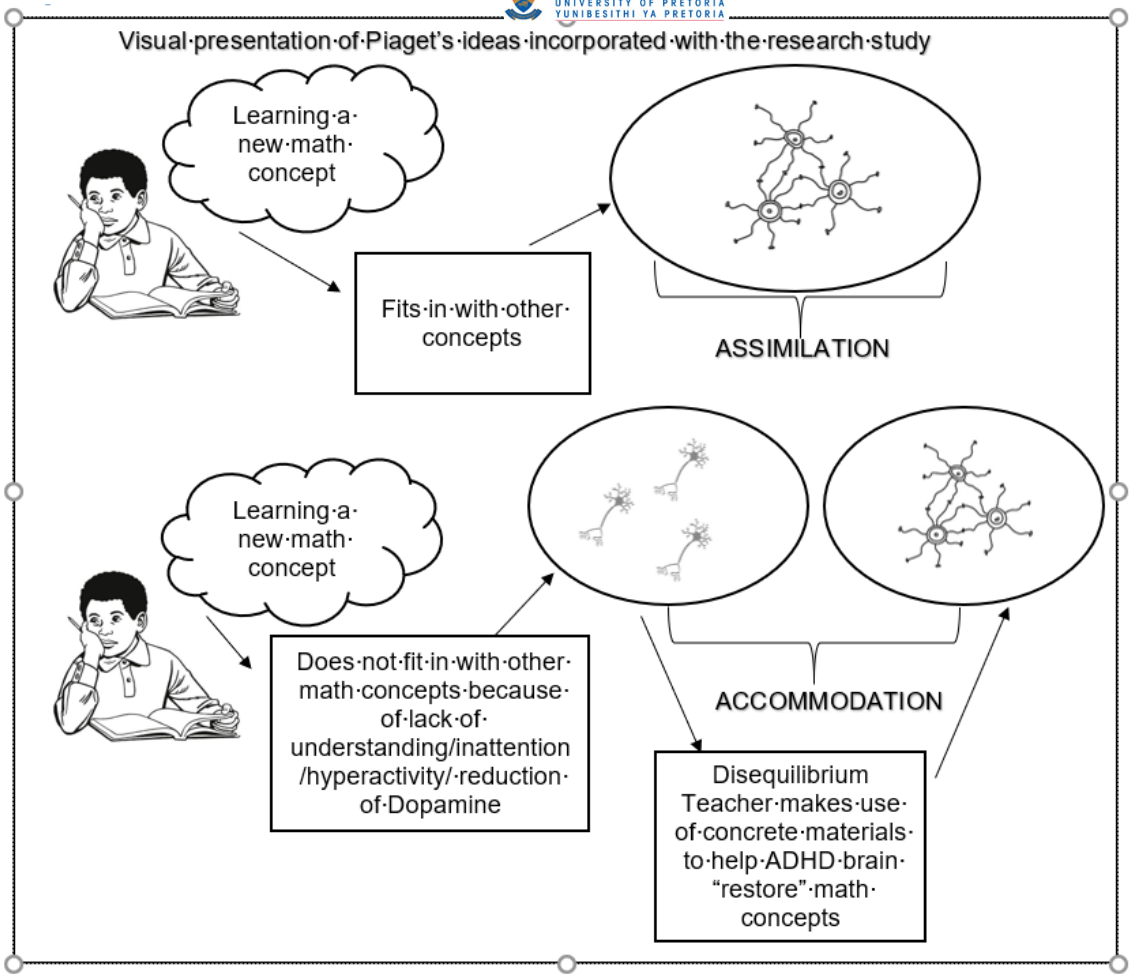


Figure 5.2: Illustration of the importance of Piaget's ideas incorporated in the research study

Figure 5.2 illustrates the importance of Piaget's ideas in the investigated research study. The first figure shows what happens when a learner learns a new concept that fits into their understanding. The second figure shows how different an ADHD-identified learner's brain work when they do not understand a concept and when it does not fit into their understanding. Several factors can cause the learner not to understand, like overstimulation, distractions, a teacher with a bad attitude, and overwhelmingness. The figures, therefore, illustrate the importance of using materials or exercises to help the ADHD-identified learner restore concepts in their brain so that they can move on to new concepts. The next theory is Vygotsky's sociocultural theory. Vygotsky is well known for the concept of the zone of proximal development (Muñoz-Silva *et al*., 2022). The zone of proximal development will help explain why the teacher is the main bridging force between the known and unknown for learners diagnosed with ADHD.

5.4.2 Vygotsky's sociocultural theory

This study used Vygotsky's sociocultural theory to help understand teachers' roles, personalities, and attitudes towards learners with ADHD. As mentioned in Chapter 2, the zone

of proximal development starts with the learner being unable to do the task. Vygotsky explains the importance of the assistance of an adult (teacher) to help the learner understand the task. During the interviews, the researcher asked each participating teacher what their attitude towards mathematics was and what impact it had towards their ADHD-identified learners. Most participating teachers could answer the question with the understanding that their attitudes significantly impact the learners. Teacher A from Group 1 (private school) immediately admitted that she does not like mathematics. The researcher also realised that the ADHD learners in her classroom struggled the most with mathematics by observing their mathematics books received. Teacher A also mentioned that when she presented mathematics, she mostly appeared despondent because she never looked forward to presenting the subject. Teacher A was enough proof for the researcher to understand the effect a teacher's attitude can have towards learners with ADHD, especially because ADHD learners have emotional dysfunctions (Greenblatt, 2017). Vygotsky's theory explains that the teacher must be the learner's mentor. Mentors need to be positive and motivated to teach. The zone of proximal development is the "continuum" between what a learner knows and can do independently and what a learner can do but with the assistance of a teacher (dependents) (Krüger *et al.* 2016:244).

Vygotsky emphasises the importance of the teacher being socially collaborative when learning and developing mathematics concepts occur. All five participating teachers mentioned that if they do not appear socially accommodative or "happy," they can easily lose the concentration of their ADHD learners. These comments fit into the statement of Getz (2013), where he mentions that imaging studies have implicated a difference in the corpus callosum of ADHD brains. This finding helps to explain the verbal abilities found in ADHD-identified learners. Therefore, if teachers are not social enough in a positive way, they might lose the concentration of ADHD learners, which can interfere with the zone of proximal development. However, as mentioned in Chapter 2, Swingle (2015) adds the importance of the arousal level of the classroom with ADHD-identified learners. Swingle (2015) and Leaf (2013) state that the arousal level in a teacher's classroom can influence the brain waves of an ADHD learner. Brain waves send communication from one mass of neurons to another, bringing together the regions of the brain to produce experience. This means that if the teacher is "too" social or "too" quiet, either way, she might lose the concentration of her ADHD learner, which can affect the learner trying to learn new mathematics concepts. Therefore the personality of a teacher is important to keep in mind when working with ADHD-identified learners. Figure 5.3 illustrates how the zone of proximal development works and the

importance of the sociocultural theory of Vygotsky on the neurodevelopment of an ADHD brain.

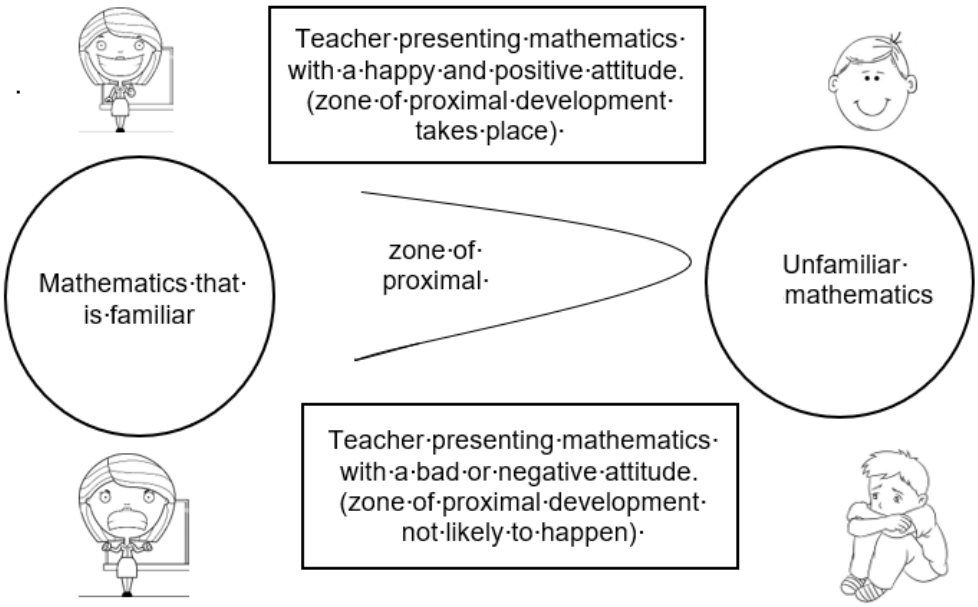


Figure 5.3: Illustration of the ZPD's importance on the sociocultural theory of Vygotsky on the neurodevelopment of ADHD

5.4.3 Donald Olding Hebb's predominantly neurophysiological theory

The study used Hebb's predominantly neurophysiological theory to help understand the neurodevelopment of the ADHD brain because it has a link between brain science and the learning of mathematics. As mentioned in Chapter 2, according to Hebb, there must be an optimal level of arousal in the classroom to learn better. It was clear during the interviews that some teachers were unhappy with their classroom setup, especially the teachers from the private school. They complained about being too close to each other's classrooms and having to walk through each other's classrooms to use the toilet facilities. These interruptions will influence the classroom's arousal level and the ADHD-identified learners' attention span. Hebb explained that if arousal is too high, it is likely that the learner will operate in the environment to reduce the arousal level. This high arousal level can be why some of the learners' mathematics books had upside-down worksheets or open spaces. Hebb's theory also emphasises the importance of the teacher's knowledge about the neurodevelopment of ADHD, because a neurological factor can cause ADHD. During the interviews, the teachers were uncertain when asked, "what is your conceptualisation of ADHD neurodevelopment?".

Most participating teachers said that ADHD is a learner with concentration challenges, but it is much more than just that. This comment indicated that they did not really understand the seriousness of ADHD. It was also unclear whether the teachers used scaffolding during their lessons. It appeared that most of the time, the teachers only presented the work as required of them. Although the teachers knew what scaffolding meant, it appeared as if they did not know how to apply it to their teaching. The teachers could mention specific methods they used to make learning easier for the learners, but nothing was mentioned about how they helped the learners strengthen their long- and short-term memory. Hebb emphasises the significance of understanding the short- and long-term memory of ADHD-identified learners to make teaching and learning sufficient for them.

The researcher also deduced that the teachers did not present multiplication tables and patterns with the right methods on certain worksheets presented in the mathematics books. Some of the multiplication patterns were too complicated, influencing the learners' short- and long-term memory. There were also not enough pictures and illustrations to help explain the mathematics activities. The researcher believes that Hebb's theory is relevant to the study as it can explain why ADHD learners struggle with the mathematics that consists of extended steps or work with no steps at all, because of their feeble concentration and memory. Furthermore, Hebb's assertion states that if teachers use more sensory experiences such as building blocks or music, it can help set up neural activity in the ADHD brain, and this can also support the learner's memory challenges. During the interviews, only one teacher mentioned more than one sensory resource she used to support her learners. However, three of the five participating teachers mentioned music or songs can help to remember challenging mathematics steps. Figure 5.4 below illustrates the different neural activity in a non-ADHD brain, an active ADHD brain, and an ADHD brain in remission. The diagrams below illustrate that ADHD is caused by a neurological factor and indicates the different activity taking place in the brain. This diagram fits into the research study as it indicates some activity taking place in the frontal lobes of the ADHD learner's brain that can cause challenges, such as worksheets that are not cut out well, are pasted upside down, and untidy writing.

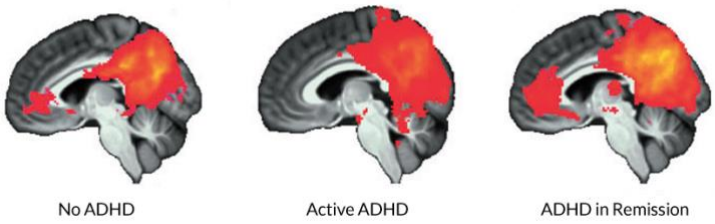


Figure 5.4: Illustration of the different activity in a non-ADHD brain versus an active ADHD brain

(Resources by science news, 2014)

The three theories made a great contribution to the study. Firstly, Piaget and Vygotsky's theories explained to the researcher and teacher why the role of a teacher is so important and why the teacher must first understand a learner's neurodevelopment before supporting the learner. In addition, Hebb's theory gave a good explanation of how a child's brain works and how it can be influenced. Secondly, all three theories helped the researcher to distinguish between which teaching methods are correct and which can be added to help understand the neurodevelopment of learners identified with ADHD. Lastly, important facts can be used from the theories to make the learning of mathematics easier for ADHD learners.

5.5 SUMMARY OF EMPIRICAL FINDINGS

This section presents a summary of the key empirical findings in terms of the five themes that were generated deductively: teachers' conceptualisation of neurodevelopment and ADHD, teachers' perspectives about ADHD neurodevelopment and the mathematical interventions in the Foundation Phase, the support teachers receive, inclusive strategies used to help learners diagnosed with ADHD, and curriculum differentiation. Data obtained from five Grade 3 teachers with more than three years of teaching experience working with ADHD-identified learners, who had a BEd or Bed (Hons) degree, and were teachers in a mainstream or private school, was analysed. This data analysis determined their understanding of ADHD, neurodevelopment, and mathematical interventions in the Grade 3 Foundation Phase classroom. ADHD neurodevelopment was investigated through the lens of the conceptual frameworks of Piaget's neuroplasticity theory, Vygotsky's sociocultural theory, and Hebb's predominantly neurophysiological theory.

If teachers have enough understanding about the neurodevelopment of ADHD-identified learners, it will help to improve the inclusive teaching and learning of mathematics. For teachers to gain more knowledge about ADHD neurodevelopment, they must get enough support from the DBE, DBST, school management, and principals. Teachers should also be educated more about ADHD through courses and teacher training programmes. In this study, only a few participating teachers gave a clear explanation of ADHD and the neurodevelopment thereof. It was also clear that the teachers from the private school received little support from their school management and DBST.

5.6 RESEARCH QUESTIONS

In Chapter 1, the researcher posed the main research and sub-research questions to guide the researcher's discussion about the collected data and analysis. The primary research question guided the researcher to collect data through semi-structured interviews with the participating teachers. The first sub-research questions dealt with the amount of knowledge teachers have about the neurodevelopment of ADHD and mathematics interventions in the Grade 3 Foundation Phase. The second sub-research question dealt with the support teachers receives in mainstream and private schools to enhance learners identified with ADHD's mathematics access. The last sub-research question served as a guide to observing teachers' understanding of inclusive strategies in connection with teaching challenging mathematics to ADHD-diagnosed learners.

5.6.1 Sub-research Question 1

What are teachers' perspectives on ADHD, neurodevelopment, and mathematics interventions in the Grade 3 Foundation Phase?

During the interviews, it was clear to the researcher that each teacher had their own perspective on ADHD, neurodevelopment, and mathematics interventions. The participating teachers could not explain the term "neurodevelopment", which made their perspective appear vague. However, most of the teachers could give one or two-sentence explanations of the ADHD disorder, but the question was not answered well enough for the researcher to conclude that the teachers know what ADHD entails. The teachers had one thing in common: to learn more about the neurodevelopment of learners diagnosed with ADHD to help improve the mathematics interventions they use.

5.6.2 Sub-research Question 2

What kind of support do teachers in mainstream and private schools receive to enhance mathematics access for learners diagnosed with ADHD?

During this question, the researcher realised that most teachers receive very little support from the school and the Department of Basic Education. This may explain why the teachers have little knowledge about ADHD and together with neurodevelopment. It also appeared that the teachers from the private school were getting less support due to financial challenges.

5.6.3 Sub-research Question 3

Which inclusive strategies do teachers in mainstream and private schools use that influence learners identified with ADHD with mathematical challenges?

The researcher concluded that the strategies used by mainstream schoolteachers are better than those in the private school. The reason for this is that the mainstream schoolteachers received more support from the school, including more suitable financial support to purchase aids and use better support for intervention strategies. From the observations of the mathematics books, it appeared that the learners did better with mathematics activities that included pictures and flow diagrams. The researcher noticed that the teachers from both schools (mainstream and private) did not always use the curriculum-prescribed work and "tips". The teachers' reasons were that the curriculum work was sometimes too much and too difficult for the ADHD-identified learners. It appeared that the teachers were not knowledgeable about curriculum differentiation. The researcher believes that the examples mentioned in the curriculum, such as flow diagrams, multiplication tables, and groups could be good examples to give teachers ideas on how to support the learners. The flowcharts and tables observed in the books appeared too difficult or too confusing for ADHD-identified learners. The researcher could also conclude that the teachers did not make enough use of concrete aids due to financial challenges.

5.6.4 Main research question

How do Grade 3 FP teachers in mainstream and private schools conceptualise ADHD and mathematics access?

Each teacher explained ADHD differently. There were only two out of the five participating teachers who could give a good explanation of the term ADHD. The other teachers "read off" the answer or could not explain the term ADHD further. Most teachers believed that some of the mathematics work mentioned in the curriculum was too difficult for ADHD-identified learners. They reckoned that the learners could not keep up with the time and amount of work expected from them, and they easily became overwhelmed.

5.7 RECOMMENDATIONS

In view of the key findings of this study, the literature review, and the aims of the study, I will provide eleven recommendations that are directed towards the National Department of Basic Education, the districts, to schools, to teachers at schools and the researcher.

5.7.1 Recommendations for the National Department of Basic Education

The following recommendations are for the National Department of Basic Education.

5.7.1.1 Recommendation 1: Implementation of policies

The National Department of Basic Education should ensure that all policies are implemented. This will help to ensure that the learning needs of not only “typically” developed learners but also learners with other learning barriers, such as ADHD, are met. This could be made possible by also involving all people responsible for the development of the policy, such as the district-based support teams and the school's management, to help identify any gaps and challenges faced around policies and their implementation.

5.7.1.2 Recommendation 2: Educating teachers more on ADHD neurodevelopment

The National Department of Basic Education should implement courses to inform teachers more about ADHD and the neurodevelopment thereof. They should also ensure enough information available for the teachers about ADHD and how to educate affected learners. This will assist teachers in learning and understanding more about their responsibilities and expectations in terms of working and understanding learners diagnosed with ADHD. This information must also include the ability to differentiate the curriculum. The National Department of Basic Education must also train teachers on the inclusive education as set out in the White Paper 6 policy guidelines for inclusive teaching and learning and the guidelines for how to work with diverse learner classrooms.

5.7.2 Recommendations for district officials

The following recommendation is intended for the district-based support teams.

5.7.2.1 Recommendation 3: Strengthening district-based support teams (DBST)

The DBST should support schools that cater to learners with learning disabilities. According to the participating teachers, they do not receive enough or any support from the DBST. The DBST’s support will help ensure that teachers are provided with support in addressing learning barriers, such as those experienced by learners diagnosed with ADHD. This support must also include creating the ability for teachers to understand the neurodevelopment of

ADHD and how to implement curriculum differentiation to make learning more accessible for ADHD-identified learners.

5.7.3 Recommendations for schools

The following recommendations are targeted at mainstream and private schools.

5.7.3.1 Recommendation 4: Establishing support networks in schools

The school must ensure that all teachers get enough support from the school's management teams. This support will help to ensure that the teachers are kept up to date about important learning disabilities and that they share resources. Furthermore, they should conduct workshops with each other at the school to share best practices on ADHD neurodevelopment and the learners' support needs. Teachers will share their knowledge and challenges regarding ADHD. The teachers can learn from each other about inclusive teaching practices and curriculum differentiation.

5.7.3.2 Recommendation 5: Developing a community of practice between schools and communities

If a school struggles financially it will be best to use available community human resources, such as retired teachers and student teachers, to help serve as assistants in the classroom. This will especially be helpful for ADHD-identified learners that need extra support. The above can also help minimise challenges, such as learners feeling overwhelmed in overcrowded classrooms that make curriculum differentiation difficult.

5.7.4 Recommendation for teacher training institutions

The following recommendations are targeted at the teacher training institutions.

5.7.4.1 Recommendation 6: Strong collaboration between the teacher training institutions, Department of Basic Education, and schools (mainstream or private)

The teacher training institutions must establish solid collaboration with the Department of Basic Education and the schools to eliminate misunderstandings between teachers and their needs. This will help ensure that the content taught in the teacher training institutions responds to the needs of the Department of Basic Education and the schools. In this case, the teachers' greatest need is to be more educated about the neurodevelopment of ADHD to help with curriculum differentiation and inclusive mathematics teaching.

5.7.4.2 Recommendation 7: Teacher's training must include an on-site approach

If a teacher is enrolled for the BEd Honours degree in Learning Support, it is still important for the teacher training programme to use on-site visits. In other words, teachers must conduct classroom visits to get a hands-on experience with the support needs of children diagnosed with ADHD. This experience will also help with the teacher's confidence in curriculum differentiation when working with these learners.

5.7.4.3 Recommendation 8: For the researcher

I am not convinced that my participants will necessarily get enough support from the Department of Basic Education or the DSBT. I am also unsure if the teachers will implement curriculum differentiation for learners with ADHD. The findings of this study have made me realise that teachers need more support to help educate them on how to understand ADHD neurodevelopment in young learners and how to educate them inclusively. Therefore, I will share the study's findings and recommendations with the participants to enlighten them on the insights for supporting ADHD learners. I can also do once-off awareness training with teachers to share scientific and research-based strategies.

5.8 RECOMMENDATION FOR FURTHER RESEARCH

Based on the findings of this study, I recommend the following for future research:

5.8.1 Recommendation 9: Teacher's knowledge of how to differentiate the curriculum for ADHD-identified learners

Since my study was based on teachers' conceptualisation of ADHD, neurodevelopment, and mathematical interventions, it would be interesting to research more deeply on teacher's conceptualisation and knowledge on how to differentiate the curriculum for ADHD learners.

5.8.2 Recommendation 10: Teacher's perspectives about their classrooms in support of ADHD neurodevelopment

The study was focused on teachers' knowledge of ADHD disorder in learners. It would be interesting to conduct further research on the "does" and "don'ts" of setting up a classroom to enhance with information processing of an ADHD learner and also to examine the resources available in the classrooms such as tables, chairs, pictures on the wall, and white boards.

5.8.3 Recommendation 11: The use of successful strategies to help ADHD-identified learners

During the study, I realised teachers do not understand which strategies are best when working with ADHD learners. It would be interesting to find out which strategies in South African schools relate to those recommended in the literature and identify which are beneficial in the context of ADHD.

5.9 LIMITATIONS

It is necessary to acknowledge that this research involved teachers of only one private school and one mainstream school. My selection of participating teachers renders the research trustworthy. I anticipated that the result of this study would help realise the importance of a teacher's job to understand their learners, especially if the learner has any learning disabilities. I believe that if the teachers are better trained in the neurodevelopment of ADHD, it could make their work as teachers easier and improve the future participation of that learner in society.

5.10 CONCLUSION

Undertaking this research study was very rewarding, and it contributed greatly to my growth as a teacher and tutor working with ADHD-identified learners. I view this study as an essential step in recognising the gaps in schools and the education of teachers that need to be addressed by the National Department of Basic Education and the DBST. Before this research study, I always relied on the literature, which encompassed the understanding of ADHD neurodevelopment and how beneficial it can be for teachers to understand the brain functioning of ADHD to improve mathematics teaching in inclusive teaching.

From this study as a researcher, I gained more information about the development of an ADHD brain, and the knowledge teachers have in this regard. I also learned about the differences between mainstream and private schools and teachers' challenges regarding support and finances. Receiving first-hand insights from teachers about their understanding of ADHD, neurodevelopment, and mathematics interventions was an eye opener and emotionally draining at times to realise how little passion some of the teachers had left. In particular, I felt deeply for learners diagnosed with severe ADHD, which they and their parents cannot resolve on their own. I also felt for the teachers who received little support from their school management and the District Based Support Teams.

Akyeampong, E.K., Hill, A.G. & Kleinman, A. eds. 2015. *The culture of mental illness and psychiatric practice in Africa*. Bloomington: Indiana University Press. Available at: https://univofpretoria.on.worldcat.org/search/detail/908031251?queryString=Lund%2C%20Sorsdahl%2C%20and%20Stein&clusterResults=true&groupVariantRecords=false [Accessed on 12 March 2021.

Allen, J.B. & Gramlich, C.A. 2019. N*europsychology. Salem Press Encyclopedia of Health:* Retrieved from https://search-ebscohost com.nwulib.nwu.ac.za/login.aspx?direct=true&db=ers&AN=93872121&site=eds-live [Accessed on 23 Nov. 2020.

American Academy of Child and Adolescent Psychiatry. 2017. *ADHD & the Brain*. Retrieved from https://www.aacap.org/AACAP/Families_and_Youth/Facts_for_Families/FFF-Guide/ADHD_and_the_Brain-121.aspx [Accessed 3 March 2023]

Anderson, V., Efron, D., Fuelscher, I., Hyde, C., Sciberras, E. & Silk, T. 2020. Understanding motor difficulties in children with ADHD: A fixel-based analysis of the corticospinal tract. Journal of *Progress In Neuro-Psychopharmacology and Biological Psychiatry*, 105:110-125. doi:10.1016/j.pnpbp.2020.110125 [Accessed on 10 Jan. 2021].

Ayaz, H. & Dehais, F. eds. 2019. *Neuro-ergonomics: The brain at work and in everyday life.* London, United Kingdom: Academic Press is an imprint of Elsevier. Retrieved from https://ebookcentral-proquest-com.uplib.idm.oclc.org/lib/pretoria-ebooks/reader.action?docID=5602400 [Accessed on 20 Jan. 2021].

Ayehsabu, A.P. 2020. *Promoting inclusiveness through an inclusive leadership framework in culturally diverse South African schools*. PhD thesis. Potchefstroom: North-West University.

Badenes, R.L., Berchiatti, M., Ferrer, A. & Longobardi, C. 2022. School Adjustments in Children with Attention Deficit Hyperactivity Disorder (ADHD): Peer Relationships, the Quality of the Student-Teacher Relationship, and Children's Academic and Behavioral Competencies. *Journal of Applied School Psychology*, 38(3):241-261. Retrieved from doi 10.1080/15377903.2021.1941471 [Accessed on 20 Feb. 2022].

Bakker, N. 2015. Brain disease and the study of learning disabilities in the Netherlands. *Paedagogica Historica,* 51(3):350-364. Retrieved from https://doi.org/10.1080/00309230.2014.929594 [Accessed on 25 Sep. 2022.]

Batka, M.M. & Deventer, V.V. 2013. *A Student's A-Z of Psychology.* 2nd ed. Pretoria: Juta.

Bazeley, P. 2013. *Qualitative Data Analysis Practical Strategies*. London: Sage Publications: Retrieved from https://books.google.co.za/books?id=33BEAgAAQBAJ&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false [Accessed on 2 Jan. 2022.]

Bernstein, E. & Lysniak, U. 2018. *Semi-Structured Interviews and Non-Participant Observations: Teacher Instruction of Competitive Activities for Multicultural Students*. London SAGE Publications, Ltd: Available at: <http://www.doi.org.uplib.idm.oclc.org/10.4135/9781526444134> [Accessed on 13 Dec. 2021.

Bornman, J. & Rose, J. 2010. *Believe that all can achieve increasing classroom participation in learners with special support needs*. Pretoria: Van Schaik.

Bos, C.S., Schumm, J. S. & Vaughn, S. 2007. *Teaching students who are exceptional, diverse, and at risk in the general education classroom*. Boston: Pearson.

Bremner, R. & Thompson, A. M. 2016. *The boy from hell: life with a child with ADHD*. London, Jessica Kingsley: Retrieved from http://linker2.worldcat.org/?jHome=https%3A%2F%2Fuplib.idm.oclc.org%2Flogin%3Furl%3Dhttp%3A%2F%2Fsearch.ebscohost.com%2Flogin.aspx%3Fdirect%3Dtrue%26scope%3Dsite%26db%3Dnlebk%26AN%3D1160116&linktype=best [Accessed on 29 Jan. 2021.

Brinkmann, S. 2013. *Qualitative interviewing*. Oxford University: Sage Publications.

Brundrett, M. & Rhodes, C. 2013. *Theories of educational research*. London, Safe Publishing: Retrieved from https://www.sagepub.com/sites/default/files/upmbinaries/58936_Brundett_&_Rhodes.pdf [Accessed on 21 Sep. 2021.

Buchanan, K. & Buchanan, T. 2016. Relationships with families: Have educators overlooked a critical piece of the puzzle? *Improving Schools*, 17(1): 18-29. Retrieved from https://files.eric.ed.gov/fulltext/EJ1198468.pdf [Accessed on 25 Jan. 2021].

Carter, R. 2019. *The Brain Book. An illustrated guide to its structure, function, and disorders.* London: Dorling Kindersley Limited.

Charlesworth, R. & Lind, K.K. 2012. *Mathematics and Science for young children*. 5th ed. New York: Thomson Delmar Learning.

Chinn, S.J. 2018. *Mathematics learning difficulties, dyslexia, and dyscalculia*. 2nd ed. London: Jessica Kingsley. Available at: https://web-s-ebscohost-com.uplib.idm.oclc.org/ehost/detail/detail?vid=0&sid=e7227e1a-1fd7-4c9a-9bca-

8985ee2a075d%40redis&bdata=JnNpdGU9ZWhvc3QtbGl2ZSZzY29wZT1zaXRl#AN=1816614&db=nlebk [Accessed on 18 Dec. 2021.]

Collie, R.J., Frydenberg, E. & Martin, J.A. ed. 2017. Social and emotional learning in Australia and the Asia-Pacific: Perspectives, programs, and approaches. *Social and emotional learning in the Australasian context*.

Corbin, J.M. & Strauss, A.L. 2015. *Basics of qualitative research: techniques and procedures for developing grounded theory*. ed. Thousand Oaks, California. Retrieved from https://methods-sagepub-com.uplib.idm.oclc.org/book/basics-of-qualitative-research [Accessed on 21 Jan 2021.

Creswell, J. 2016. *Thirty Essential skills for the qualitative researcher*. Thousand Oaks, CA: Sage Publications.

Davin, R. & Naude, M. 2017. *Assessment in the Foundation Phase*. Pretoria: Van Schaik.

Dei, G.J.S., Mahlo, D. & Phasha, N. 2017. *Inclusive schooling and education in African contexts: Inclusive education in African contexts*. Rotterdam: Sense Publishers: Retrieved from https://link.springer.com/chapter/10.1007%2F978-94-6300-803-7_1 [Accessed 3 Jan. 2021].

Deloche, G. & Seron, X. 2019. *Mathematical disabilities: A cognitive neuropsychological perspective.* London, Routledge: Retrieved from https://www-taylorfrancis-com.uplib.idm.oclc.org/books/mathematical-disabilities-g%C3%A9rard-deloche-xavier-seron/e/10.4324/9780429488542 [Accessed on 9 Feb. 2021.

Department of Basic Education. (DBE) 2001. *Education White Paper 6: Special Needs Education.* Pretoria. Retrieved from https://www.gov.za/documents/special-needs-education-education-white-paper-6. [Accessed 2 March 2023]

Department of Basic Education. (DBE) 2011. *Conceptual and operational guidelines for the implementation of inclusive education: Full-service schools*. Pretoria. South Africa.

Department of Basic Education (DBE). 2016*. Regulations pertaining to the National Curriculum Statement Grades R-12.* Pretoria.

Donald, D.R., Lazarus, S. & Lolwana, P. 2010. *Educational psychology in social contexts. Exosystemic applications in Southern Africa*. 4th ed. Southern Africa: Oxford University Press.

Donald, D. R. Lazarus, S. & Moola, N. eds. 2014*. Educational psychology in social context: ecosystemic applications in Southern Africa.* 5thed. Cape Town: Oxford University Press.

Dreyer, J. 2014. *The Educator as Assessor*. Pretoria: Van Schaik.

Faber, H. 2017. *The mathematics handbook for students with mathematics difficulties, dyscalculia, dyslexia, or ADHD: (Grade 1-7).* Universal Publishers, La Vergne: Retrieved from https://ebookcentral-proquest-com.uplib.idm.oclc.org/lib/pretoria-ebooks/detail.action?docID=5199865 [Accessed on 24 Feb. 2021.]

Forlin, C. & Loreman, T. ed. 2014. *Measuring inclusive education.* Emerald Publishing Limited, Bingley: Retrieved from https://ebookcentral.proquest.com/lib/northwuebooks/reader.action?docID=1840437 [Accessed on 29 Jan. 2021.

Gawe, N., Jacobs, M. & Vakalisa. N.C.G. eds. 2011. *Teaching-learning dynamics. 4th* ed. Cape Town: Pearson.

Getz, G.E. 2013. *Applied Biological Psychology*. Springer Publishing Company, Incorporated, New York: Retrieved from https://ebookcentral-proquest-com.uplib.idm.oclc.org/lib/pretoria-ebooks/reader.action?docID=1619913 [Accessed on 22 Oct. 2022.]

Goldberg, E. ed. 2017. *Executive functions in health and disease. Elsevier Science & Technology.* San Diego. Retrieved from https://ebookcentral-proquest-com.uplib.idm.oclc.org/lib/pretoria-ebooks/reader.action?docID=4882588 [Accessed on 19 Feb. 2021.

Greenblatt, J. 2017. *Finally focused. The breakthrough natural treatment plan for ADHD that restores attention, minimizes hyperactivity, and helps eliminate drug side effects.* New York: Harmony.

Haenssgen, M.J. 2019. *Interdisciplinary qualitative research in global development: a concise guide.* Bingley: Emerald Publishing Limited (Emerald points). Retrieved from https://ebookcentral-proquest-com.uplib.idm.oclc.org/lib/pretoria-ebooks/detail.action?docID=5979604 [Accessed on 29 March 2021.]

Harpin, V. ed. 2017. *The management of ADHD in children and young people: The management of ADHD in children and young people*. Mac Keith Press: Retrieved from https://ebookcentral-proquest-com.uplib.idm.oclc.org/lib/pretoria-ebooks/detail.action?docID=4795352 [Accessed on 9 Jan. 2021.

Hartell, C., Joubert, I. & Lombard, K. eds. 2016. *Navorsing: 'n Gids vir die beginnernavorser.* Pretoria: Van Schaik.

Hebb D.O. 1980. *Essay on mind*. Hillsdale NJ: Erlbaum.

Hergenhahn, B.R. & Olson, M.H. 2012. *Introduction to theories of learning.* 9th ed. Taylor & Francis Group, London. Retrieved from https://ebookcentral-proquest-

com.uplib.idm.oclc.org/lib/pretoria-ebooks/reader.action?docID=3570010 [Accessed on 20 Feb. 2021.]

Henning, E. 2013. South African research in mathematical cognition and language in childhood: Towards an expanded theoretical framework. *South African Journal of Childhood Education*, 2(3):56–76. Retrieved from https://www-proqcom.uplib.idm.oclc.org/docview/1898641521/54927FD4622C4CD3PQ/1?accountid=14717 [Accessed on 29 Jan. 2021.

Honkasilta, J., Jahnukainen, M. & Sandberg, E. 2014. ADHD in the context of Finnish basic education. *Journal of Emotional and Behavioral Difficulties.* 19(3): 311–323. doi:10.1080/13632752.2014.883789

Hudson, D. 2016. *Specific Learning Difficulties. What Teachers need to know*. Jessica Kingsley Publishers: Retrieved from https://search.ebscohost.com/login.aspx?direct=true&db=nlebk&AN=1061113&site=ehost-live&scope=site [Accessed on 15 Nov. 2021.

Iannini, A.M.N., Nazir, J. & Pedretti, E. 2018. Exploring controversy in science museums: Non-visitors and the body world exhibits. *Canadian Journal of Science, Mathematics and Technology Education*. 18: 98-113. Retrieved from https://link-springer-com.uplib.idm.oclc.org/article/10.1007/s42330-018-0014-3#citeas [Accessed on 1 March 2021.]

James, A.N. 2007. *Teaching the male brain. How boys think, feel, and learn in school.* United States of America: Crowin Press.

Johnson, J. & Reid, R. 2012. *Teacher's Guide to ADHD.* Guilford Publications, New York: Retrieved from ProQuest Ebook Central [Accessed on 3 Oct. 2022.]

Kaufman, D.E., Maricle, D.E. & Miller, D.C. 2019. *Essentials of school neuropsychological assessment.* John Wiley & Sons, Incorporated, Newark. Retrieved from https://ebookcentral-proquest-com.uplib.idm.oclc.org/lib/pretoria-ebooks/reader.action?docID=5633137 [Accessed on 9 Feb. 2021.

Kriegler, S. 2015. A Social Constructivist Perspective on the Potential Relevance of Selected Dsm-5 Disorders for South African Children and Youth. *Children & Society*, 29(6): 604–614. doi: 10.1111/chso.12097.

Krüger, D., Landsberg, E. & Swart, E. 2016. *Addressing barriers to learning*. 3rd ed. Pretoria: Van Schaik.

Kumar, R. 2014. *Research Methodology a step-by-step guide for beginners*. 4th ed. India: Sage Publications.

Leaf, C. 2013. *Switch on your brain. The key to peak happiness, thinking, and health*. Michigan: Baker Books.

Leavy, P. 2017. Research design: Quantitative, qualitative, mixed methods, arts-based, and community-based participatory research approaches. Guilford Publications. New York. Retrieved from https://ebookcentral-proquest-com.uplib.idm.oclc.org/lib/pretoria-ebooks/reader.action?docID=4832778 [Accessed on 13 April 2021.]

Louw, A.E. & Louw, D.A. 2007. *Child and adolescent development.* Bloemfontein, South Africa: Psychology Publications.

Mack, L. 2010. *The philosophical underpinning of educational research*. Polyglossia.

Makoelle, T.M. ed. 2016. *Inclusive Teaching in South Africa: African Sun Media*. Stellenbosch. DOI: 10.18820/9781928355038

Manicka, N.S. 2018. *Inclusive Education in South Africa and the Developing World: The Search for an Inclusive Pedagogy.* Emerald Publishing Limited, Bingley: Retrieved from ProQuest Ebook Central [Accessed on 12 Oct. 2022.

Maree, J.K. ed. 2007. *First steps in research.* Pretoria: Van Schaik.

Maree, J.K. 2012. *Complete your thesis or dissertation successfully: practical guidelines*. Cape Town: Juta.

Maringe, F., & Prew, M. (Eds.). 2015. *Twenty years of education transformation in Gauteng 1994 to 2014*. African Books Collective.

Maricle, D.E. & Miller, D.C. 2019. *Essentials of School Neuropsychological Assessment.* John Wiley & Sons, Incorporated, Newark. Retrieved from https://ebookcentral-proquest-com.uplib.idm.oclc.org/lib/pretoria-ebooks/reader.action?docID=5633137 [Accessed on 11 Nov. 2021.]

Maringe, F. & Prew, M. eds. 2015. *Twenty Years of Education Transformation in Gauteng 1994 to 2014: African Minds.* Cape Town. Retrieved from ProQuest Ebook Central [Accessed on 7 Oct. 2022.]

Marshall, C. & Rossman, G. B. 2016. *Designing qualitative research*. 6th ed. Thousand Oak s, California: Sage Publications.

Mash, E.J. & Wolfe, D.A. 2019. *Abnormal child psychology*. 7th ed. Boston, MA: Cengage Learning.

Maxwell, J A. 2013. *Qualitative Research Design: An Interactive Approach.* 3rd ed. Los Angeles: Sage.

McGinn, N.F. & Schiefelbein, E. 2017. *Learning to educate: Proposals for the reconstruction of education in developing countries.* Dordrecht: BRILL. Retrieved from:

https://ebookcentral-proquest-com.uplib.idm.oclc.org/lib/pretoria-ebooks/reader.action?docID=4843716 [Accessed 1 April 2021].

McGough, J. 2014. *ADHD.* Oxford: Oxford University Press, Incorporated, Cary. ProQuest E-book Central.

Meier, C. & Naude, M. 2014. *Teaching foundation phase mathematic: A guide for South African students and teachers*. Pretoria: Van Schaik.

Mertens, D.M. 2014. *Research and evaluation in education and psychology: Integrating diversity with quantitative, qualitative, and mixed methods.* London: Sage Publications.

Mollon, P. 2015. *The disintegrating self: Psychotherapy of adult ADHD, autistic spectrum, and somato-psychic disorders*. Taylor & Francis Group.

Muñoz-Silva, A., Lago-Urbano, R. & Sanchez-Garcia, M. 2017. Family Impact and Parenting Styles in Families of Children with ADHD *Journal of Child and Family Studies*, 26(10): 2810-2823. Retrieved from doi: 10.1007/s10826-017-0798-1 [Accessed on 20 Oct. 2022.]

Nazarbolandb, N., Abedivzadeha, N. and Ghanbaric, S. 2019. The role of anxiety in executive functions of children with attention deficit hyperactivity disorder and mathematical learning disability comorbidity. *Journal of Neurodevelopmental Cognition*, 2(2):1-11. Retrieved from: https://www.researchgate.net/publication/333816245_The_Role_of_Anxiety_in_Executive_Functions_of_Children_with_Attention_Deficit_Hyperactivity_Disorder_and_Mathematical_Learning_Disability_Comorbidity. [Accessed on 30 Nov. 2020].

Nel, M., Engelbrecht, A., Swanepoel, H., & Hugo, A. 2013. Embracing diversity through multi-level teaching for foundation, intermediate and senior phase. In Engelbrecht, A. & Swanepoel, H. eds. Cape Town: Juta.

Pather, S. & Slee, R. 2018. *Challenging inclusive education policy and practice in Africa*. Boston: BRILL. Retrieved from https://public.ebookcentral.proquest.com/choice/publicfullrecord.aspx?p=5615315 [Accessed on 9 Dec. 2020.

Pratt, D. 2002. Reconceptualizing the Evaluation of Teaching Higher Education. *Higher Education*, 34(4): 23-44. Netherlands: Kluwer Academic Publishers.

Rodrigues, S. 2018. *Analyzing Talk in Educational Research. New York: Routledge publications:* Retrieved from https://books.google.co.za/books?id=u-1GDwAAQBAJ&printsec=frontcover&source=gbs_ViewAPI&redir_esc=y#v=onepage&q&f=false [Accessed on 2 Jan. 2022.

Sheppard, D. 2022. *Understanding and supporting neurodevelopmental needs: A systematic review of prospective memory in children and adults with ADHD; and an investigation of the underlying cognitive mechanisms of stress appraisal of classroom assistants and teachers of autistic students* (Doctoral thesis). University of Eidinburgh.

Sjöwall, D., & Thorell, L.B. 2022. Neuropsychological deficits in relation to ADHD symptoms. Quality of life, and daily life functioning in young adulthood. *Applied Neuropsychology: Adult*, 29(1): 32-40. Retrieved from https://doi.org/10.1080/23279095.2019.1704287 [Accessed on 30 Feb. 2022.

Sternberg, R.J. & Sternberg, K. 2012. *Cognitive Psychology*. 6th ed. Oklahoma: Wadsworth.

Swingle, P.G. 2015. *Adding neurotherapy to your practice: Clinician's guide to the clinically, neurofeedback, and brain driving*. New York: Springer International Publishing: Retrieved from https://books.google.co.za/books?id=2172BwAAQBAJ&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false [Accessed on 15 Nov. 2021.]

Tapia, R.A. 2012. *Child Psychotherapy: Integrating Development Theory into Clinical Practice*. New York: Springer Publishing Company.

Young, S. & Smith, J. 2017. *Helping children with ADHD: A CBT guide for practitioners, parents, and teachers.* Hoboken, NJ: John Wiley & Sons.

6 APPENDICES

6.1 APPENDIX A: EXAMPLE OF THE PREMISSION LETTER TO THE DEPARTMENT OF EDUCATION

Gauteng Department of Education
President Towers
265 Pretorius Street
Pretoria Central
Pretoria
0001

Dear Madam 27 June 2022

INFORMED CONSENT LETTER FOR TSHWANE EAST DISTRICT SCHOOLS: PUBLIC PRIMARY AND PRIVATE SCHOOLS

I am currently studying for a master's degree in the Faculty of Education at the University of Pretoria. I hereby wish to apply for permission to conduct my research study at some of the primary schools which fall under the jurisdiction of your department in the Pretoria East District. My research project will involve Grade 3 teachers and the mathematics books of learners diagnosed with ADHD in their classrooms. My research topic is: **Investigating teachers' conceptualisation of ADHD neurodevelopment and mathematical interventions in Grade 3 Foundation Phase classes**.

I want to conduct this research project because the literature has reported an increase in the number of children diagnosed with ADHD, and teachers are likely to have these learners in their classrooms. Children diagnosed with ADHD experience difficulties with mathematics because of their brain functions. Studies show that 84% of learners diagnosed with ADHD score poorly in mathematics, and most FP teachers are not well equipped to identify learners with ADHD. As the researcher in this study, I aim to find out how teachers support

learners identified with ADHD with mathematical challenges and to determine teachers' understanding of ADHD and neurodevelopment.

In order to achieve the aim of the research project I need to gather data from Grade 3 teachers with learners diagnosed with ADHD in their classrooms. Therefore, I am asking for permission to interview Grade 3 teachers and ask for worksheets and a narration of the methods they use to support learners diagnosed with ADHD and who are struggling with mathematics. If Covid-19 persists, I will conduct online interviews with the teachers and ask them to send the learners' worksheets and the narrations via email. The teachers' participation of this study will be voluntary, and they may withdraw at any time without any consequences. The data obtained will be used confidentially and anonymously for research purposes, as the data sets are the intellectual property of the University of Pretoria. The confidentiality and privacy applicable to this study will bind future research studies.

The research results will be made available upon request after completing the project. The research data will be stored in electronic format and as a hard copy at the University of Pretoria for 15 years in compliance with the ethical requirements of the university. The results of this study may also be shared with other professionals in articles or during conference presentations.

I hope this letter will provide you with adequate information to enable you to grant me the permission to conduct the proposed research project at schools falling under your jurisdiction. In the event of you requiring additional information, do not hesitate to contact me or my supervisor.

Kind regards
Stefnie Loots (Researcher)

Stefnie Loots (Researcher)
E-mail: stefnieloots@gmail.com
Cell: 0711006957

Dr Susan Thuketana (Supervisor)
E-mail: susan.thuketana@up.ac.za
Cell: 0836757899

6.2 APPENDIX B: EXAMPLE OF THE PERMISSION LETTER TO THE HEAD OFFICE

Head of The Department
Department of Education
PO Box 7710
JOHANNESBURG
2000

Dear Sir/ Madam 27 June 2022

INFORMED CONSENT LETTER FOR HEAD OF DEPARTMENT

I am currently studying for a master's degree in the Faculty of Education at the University of Pretoria. I hereby wish to apply for permission to conduct my research study at some of the primary schools, which fall under the jurisdiction of your department in the Tshwane East District. My research project will involve Grade 3 teachers and the mathematics books of learners diagnosed with ADHD in their classrooms. My research topic is: **Investigating teachers' conceptualisation of ADHD neurodevelopment and mathematical interventions in Grade 3 Foundation Phase classes**.

I want to conduct this research project because the literature has reported an increase in the number of children diagnosed with ADHD, and teachers are likely to have these learners in their classrooms. Children diagnosed with ADHD experience difficulties with mathematics because of their brain functions. Studies show that 84% of learners diagnosed with ADHD score poorly in mathematics, and most FP teachers are not well equipped to identify learners with ADHD. As the researcher in this study, I aim to find out how teachers support learners identified with ADHD with mathematical challenges and to determine teachers' understanding of ADHD and neurodevelopment.

In order to achieve the aim of the research project I need to gather data from Grade 3 teachers with learners diagnosed with ADHD in their classrooms. Therefore, I am asking for permission to interview Grade 3 teachers and ask for the worksheets and a narration of the methods they use to support learners diagnosed with ADHD and who are struggling with mathematics**.** If Covid-19 persists, I will conduct online interviews with the teachers and ask them to send the learners' worksheets and the narrations to me via email. Teacher participation of this study

will be voluntary, and they may withdraw at any time without any consequences. The data obtained will be used confidentially and anonymously for further research purposes, as the data sets are the intellectual property of the University of Pretoria. The confidentiality and privacy applicable to this study will bind future research studies.

The research results will be made available on request after completing the project. The research data will be stored in electronic format and as a hard copy at the University of Pretoria for 15 years in compliance with the ethical requirements of the university. The results may also be shared in articles or during conference presentations with other professionals.
I hope this letter will provide you with adequate information to enable you to grant me permission to conduct the proposed research project at schools falling under your jurisdiction. In the event of you requiring additional information, do not hesitate to contact me or my supervisor.

Kind regards
Stefnie Loots (Researcher)

Stefnie Loots (Researcher)
E-mail: stefnieloots@gmail.com

Cell: 0711006957

Dr Susan Thuketana (Supervisor)
E-mail: susan.thuketana@up.ac.za

Cell: 0836757899

6.3 APPENDIX C: EXAMPLE OF THE PERMISSION LETTER TO THE PRINCIPAL

Dear Principal 27 June 2022

INFORMED CONSENT LETTER FOR PRINCIPALS

REQUESTING PERMISSION TO CONDUCT RESEARCH AT YOUR SCHOOL

I am currently studying for a master's degree in the Faculty of Education at the University of Pretoria. I need to conduct a research project in partial fulfilment of the requirements for this degree. My research topic is**: Investigating teachers' conceptualisation of ADHD neurodevelopment and mathematical interventions in Grade 3 Foundation Phase classes.**

I want to conduct this research project because the literature has reported an increase in the number of children diagnosed with ADHD, and teachers are likely to have learners with ADHD in their classrooms. Children diagnosed with ADHD experience difficulties with mathematics because of their brain functions. Studies show that 84% of learners with ADHD score poorly in mathematics, and most FP teachers are not well equipped to identify these learners in their classes. As the researcher in this study, I aim to determine how teachers support ADHD learners with mathematical challenges and to learn more about their understanding of ADHD and neurodevelopment.

In view of the information provided above, I am requesting permission to interview the teachers at your school. I will conduct semi-structured interviews with Grade 3 teachers and ask for the learners' worksheets and teachers' narrations of the methods they use to support learners diagnosed with ADHD and struggling with mathematics**.** If Covid-19 still persists, I will conduct online interviews with the teachers and ask them to send the learners' documents via email. I have attached a copy of the interview schedule and observation protocol below for your information.

Parents will be given informed consent letters to explain the reason for and the objectives of the researchers' study. During this study, no learner will be interviewed, only the teachers. However, each Grade 3 learner will be requested to give their assent for the research project. Participation will be voluntary, and you may withdraw at any time without any consequences. All the information gathered will be treated as confidential, and the anonymity of the participants and that of the school will be maintained.

The research results will be made available on request after the completion of the project. The research data will be stored both in electronic format and as a hard copy at the University of Pretoria for 15 years in compliance with the ethical requirements of the university. The results may also be shared with other professionals in articles or during conference presentations, and all persons who will have access to the research data will be identified.
If you are willing to allow your school to participate in this research, please fill in the consent form provided below. If you have any questions, do not hesitate to contact me or my supervisor.

Kind regards
Stefnie Loots (Researcher)

_____ _____

Stefnie Loots (Researcher)
E-mail: stefnieloots@gmail.com
Cell: 0711006957

Dr Susan Thuketana (Supervisor)
E-mail: susan.thuketana@up.ac.za
Cell: 0836757899

PERMISSION TO CONDUCT RESEARCH PROJECT

I, _____, Principal of _____ agree / do not agree to allow Stefnie Loots to conduct research at my school. The topic of the research is: **Investigating teachers' conceptualisation of ADHD neurodevelopment and mathematical interventions in Grade 3 Foundation Phase classes**

Signature: _____ Date: _____

6.4 APPENDIX D: EXAMPLE OF PERMISSION LETTER TO PARENTS AND ASSENT LETTER FOR LEARNERS

Dear Sir/Madam 27 June 2022

INFORMED CONSENT LETTER FOR PARENTS/CAREGIVERS

I am currently studying for a master's degree in the Faculty of Education at the University of Pretoria. I need to conduct a research project in partial fulfilment of the requirements for this degree. My research topic is**: Investigating teachers' conceptualisation of ADHD neurodevelopment and mathematical interventions in Grade 3 Foundation Phase classes.**

I want to conduct this research project because the literature has reported an increase in the number of children diagnosed with ADHD, and teachers are likely to have these learners in their classrooms. Children diagnosed with ADHD experience difficulties with mathematics because of their brain functions. Studies show that 84% of ADHD learners score poorly in mathematics, and most FP teachers are not well equipped to identify learners with ADHD and provide them with the necessary support. As the researcher in this study, I aim to achieve the following objectives: to find out how teachers in schools support ADHD learners with mathematical challenges and to determine teachers' understanding of ADHD and neurodevelopment.

In the light of what has been mentioned above, I request permission to look at your child's mathematics book to gather data for the research project. If Covid-19 still persists, I will conduct online interviews with the teachers and ask them to send the learners' documents via email. I will also ask the principal to identify classes with learners diagnosed with ADHD. The data obtained will be used confidentially and anonymously for further research purposes, as the data sets are the intellectual property of the University of Pretoria. The confidentiality and privacy applicable to this study will bind future research studies. It is also important to

understand that you may choose to leave the research study at any time without any consequences to your child's mathematics or the teacher being interviewed. The research results will be made available upon request after completing the project. The research data will be stored in electronic format and as a hard copy at the University of Pretoria for 15 years in compliance with the ethical requirements of the University. The results may also be shared with other professionals in articles or during conference presentations.

I hope this letter has provided adequate information to enable you to consider giving your consent for the researcher to observe your child's books and worksheets for the proposed study. If you agree, please sign the reply slip; also feel free to contact the researcher and the supervisor at the email addresses and cell phone numbers given below.

Kind regards

Stefnie Loots (Researcher)

Stefnie Loots (Researcher)
Email: stefnieloots@gmail.com
Cell: 0711006957

Dr. Susan Thuketana (Supervisor)
Email: susan.thuketana@up.ac.za
Cell: 0836757899

CONSENT TO PARTICIPATE IN THE RESEARCH PROJECT: PARENTS/CAREGIVERS

INFORMED CONSENT: REPLY SLIP

I……. hereby give /do not give consent to the researcher to observe my child's mathematics worksheets and books. I also understand the contents of the abovementioned research project.

Signature: Parent……. Date: ……

ASSENT LETTER TO THE GRADE 3 LEARNERS

Dear Grade, 3 Learner 27 June 2022

I am currently studying for a master's degree in the Faculty of Education at the University of Pretoria. Your parents have already permitted me to observe your mathematics books and worksheets. If you do not agree with your parents you are allowed to say no, and there will be no consequences.

If you agree with your parents to allow me to observe your mathematics book and worksheets, you can circle the smiling face, if not, circle the angry face.

Thank you
Stefnie Loots (Researcher)

_____ _____

Stefnie Loots (Researcher) Dr Susan Thuketana (Supervisor)

6.5 APPENDIX E: EXAMPLE OF THE PERMISSION LETTER TO THE TEACHER

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Education
Fakulteit Opvoedkunde
Lefapha la Thuto

Dear Grade 3 teacher, 27 June 2022

INFORMED CONSENT LETTER FOR GRADE 3 TEACHER

I am currently studying for a master's degree in the Faculty of Education at the University of Pretoria. I need to conduct a research project in partial fulfilment of the requirements for this degree. My research topic is**: Investigating teachers' conceptualisation of ADHD neurodevelopment and mathematical interventions in Grade 3 Foundation Phase classes.**

I want to conduct this research project because the literature has reported an increase in the number of children diagnosed with ADHD, and teachers are likely to have learners diagnosed with ADHD in their classrooms. Children diagnosed with ADHD experience difficulties with mathematics because of their brain functions. Studies show that 84% of learners with ADHD score poorly in mathematics, and most FP teachers are not well equipped to identify these learners in their classes. As the researcher in this study, I aim to find out how teachers support learners identified with ADHD with mathematical challenges and to determine their understanding of ADHD and neurodevelopment.

In view of the information provided above, you are requested to participate in this research study. The participation that is requested from you, as a teacher, involves answering of a set of questions during a semi-structured interview. The researcher will also ask for learners' worksheets and teachers' narrations of the methods they use to support learners diagnosed with ADHD and who are struggling with mathematics. If Covid-19 still persists, I will conduct online interviews with the teachers and ask them to send learners' documents via email. The research project will have no direct benefit for you, but your input will contribute to more in-depth knowledge regarding how teachers understand

ADHD, neurodevelopment, and which steps can be taken to support teachers that are not well-equipped with regard to the requisite tools and knowledge to support learners diagnosed with ADHD, and who are struggling with mathematics.

Parents will be given informed consent letters to explain the reason for the researchers' study as well as her intentions with this research. During this study, no learner will be interviewed, only the teachers. However, each Grade 3 learner will give assent to be part of this research project. The teachers' participation in this study will be voluntary, and they may withdraw at any time without any consequences. All the information gathered will be treated as confidential and the anonymity of the participants and that of the school will be maintained.

The research results will be made available on request after the completion of the project. The research data will be stored in both electronic format and as a hard copy at the University of Pretoria for 15 years in compliance with the ethical requirements of the University. The results may also be shared with other professionals in articles or during conference presentations and all persons who may have access to the research data, will be identified.

In order to give your consent to participate in this study, please fill in the consent form provided below. One form gives consent to participate in the research project and the other form gives consent to have the proceedings of the interview voice recorded. If you have any questions, do not hesitate to contact me or my supervisor.

Kind regards
Stefnie Loots (Researcher)

Stefnie Loots (Researcher)
E-mail: stefnieloots@gmail.com
Cell: 0711006957

Dr Susan Thuketana (Supervisor)
E-mail: susan.thuketana@up.ac.za
Cell: 0836757899

CONSENT TO PARTICIPATE IN THE RESEARCH PROJECT: PRIMARY SCHOOL EDUCATORS

INFORMED CONSENT: REPLY SLIP

I……. hereby give /do not give consent of participation in the abovementioned research project. I understand that I can withdraw at any stage of the research project and that my identity will not be disclosed.

Signature: Participant …….. Date: ……

CONSENT TO ATTEND TO ZOOM MEETING: PRIMARY SCHOOL EDUCATORS

INFORMED CONSENT: REPLY SLIP
I……. hereby give /do not give consent for the interview that will take place through zoom meeting or in person to be voice recorded. I understand that the researcher needs to listen to the audio clip at a later stage so that the interview can be transcribed for the analysis of the data obtained from the interview session. I am well aware that I can withdraw at any stage of the research project and that my identity will not be disclosed.

Signature: Participant …….. Researcher: ……..
Date: ……

6.6 APPENDIX F: EXAMPLE OF THE TEACHER INTERVIEW PROTOCOL

The topic of the research is: **Investigating teachers' conceptualisation of ADHD neurodevelopment and mathematical interventions in Grade 3 Foundation Phase classes**

Time of interview: _____Duration: _____
Date: _____
Location: _____
Interviewer: _____
Interviewee: _____
Pseudonym: _____
Male/Female: _____

Teachers' conceptualisation of ADHD, neurodevelopment plays a critical role in the teaching of Foundation Phase mathematics interventions. The purpose of this study is to find out how Grade 3 teachers in mainstream and private schools' support ADHD learners with mathematics challenges, and to determine to what extent teachers, understand ADHD, and neurodevelopment. This study will also compare teachers' different strategies to support ADHD learners with regard to mathematics in mainstream and private schools. PCK (Pedagogical Content Knowledge) refers to the manner in which the teacher successfully carries his/her content knowledge across by means of instructional methods, and teaching strategies. Pseudonyms will be utilized in the interviews, data analysis and the findings. The data collected in this study will serve in research purposes only and treated as confidential. Access to the data will be granted to the researcher and the supervisor only. Please sign the consent form.

Thank you for your participation.

Questions:

1. What is your concept of neurodevelopment?
2. What is your concept of the diagnosis ADHD?
3. What are your views on ADHD, neurodevelopment, and mathematics interventions in the Foundation Phase?
4. What kind of support do you receive from the management or district-based support teams to enhance ADHD-identified learners' mathematics access?
5. Which inclusive education strategies do you use in your class that have a positive influence on learners identified with ADHD struggling with mathematics?
6. Which inclusive strategies do you use in your class that have a negative influence on learners identified with ADHD struggling with mathematics?
7. Which skills or methods do you teach learners diagnosed with ADHD to support them with multiplication in mathematics lessons?
8. How do you adjust mathematics assessments for ADHD learners?
9. Do you think the National Curriculum Statement (2003) places sufficient emphasis on mathematics for learners diagnosed with ADHD?
10. How do you support learners with ADHD to master the mathematics curricula?
11. How do you think can your attitude towards ADHD learners influence the teaching of the subject?

6.7 APPENDIX G: EXAMPLE OF THE OBSERVATION PROTOCOL

Date of observation: _____

Name of observer: _____

Teacher being observed (Pseudonym): _____

Grade: _____

Subject: _____

Reason for observation: _____

Time of observation: _____

End time of observation: _____

Teachers' conceptualisation of ADHD and neurodevelopment plays a critical role in the teaching of Foundation Phase mathematics. The purpose of this study is to investigate how Grade 3 teachers in mainstream and private schools support ADHD learners with mathematics challenges, and to understand their conceptualisation of ADHD, and neurodevelopment. This study will also compare the strategies teachers in mainstream and private schools use to support learners diagnosed with ADHD. During the observations, the researcher will observe the Grade 3 learners' mathematics books, worksheets, and the methods teachers use to assist learners struggling with mathematics.

Documents being observed:

DOCUMENTS BEING OBSERVED	MATHEMATICS BOOK	MATHEMATICS WORKSHEET	MATHEMATICS METHODS TEACHER USED
TOPIC OF THE DOCUMENT			
IS IT COMPREHENSIBLE?	Yes/ No Reason:	Yes/ No Reason:	Yes/ No Reason:
HAS THE OUTCOME BEEN ACHIEVED?	Yes/ No Reason:	Yes/ No Reason:	Yes/ No Reason:
WHAT COULD BE INCLUDED?			
WHAT COULD BE EXCLUDED?			
IS IT SUITABLE FOR LEARNERS DIAGNOSED WITH ADHD?	Yes/ No Reason:	Yes/ No Reason:	Yes/ No Reason:

6.8 APPENDIX H: EXAMPLE OF THE FIELDNOTES

DESCRIPTIVE FIELDNOTES:	**REFLECTIVE FIELDNOTES:**
Semi-structured interview: **Participant name (Pseudonym):** **Topic of interview:** **Estimated time of interview:** **Interview questions with teachers' reactions:** 1. How do you conceptualise neurodevelopment? **Teachers' reaction: comfortable/ uncomfortable** 2. How do you conceptualise the diagnosis of ADHD? **Teachers' reaction: comfortable/ uncomfortable** 3. What are your perspectives on ADHD, neurodevelopment, and mathematics interventions in the Foundation Phase? **Teachers' reaction: comfortable/ uncomfortable** 4. What kind of support do you receive from the management or district-based support teams to	

enhance ADHD learners' mastery of mathematics? **Teachers' reaction: comfortable/ uncomfortable** 5. Which inclusive education strategies do you use in your class that have a positive influence on learners identified with ADHD struggling with mathematics? **Teachers' reaction: comfortable/ uncomfortable** 6. Which inclusive strategies do you use in your class that have a negative influence on learners identified with ADHD struggling with mathematics? **Teachers' reaction: comfortable/ uncomfortable** 7. Which types of skills or methods do you teach learners diagnosed with ADHD to support them with multiplication in mathematics lessons? **Teachers' reaction: comfortable/ uncomfortable** 8. How do you adjust mathematics	

assessments for ADHD learners? **Teachers' reaction: comfortable/ uncomfortable** 9. Do you think the National Curriculum Statement (2003) places sufficient emphasis on mathematics for learners diagnosed with ADHD? **Teachers' reaction: comfortable/ uncomfortable** 10. How do you support learners with ADHD to master the mathematics curricula? **Teachers' reaction: comfortable/ uncomfortable** 11. How do you think your attitude towards ADHD learners can influence the teaching of the subject? **Teachers' reaction: comfortable/ uncomfortable**	

6.9 APPENDIX I: GDE RESEARCH APPROVAL LETTER

GAUTENG PROVINCE
Department: Education
REPUBLIC OF SOUTH AFRICA

8/4/4/1/2

GDE RESEARCH APPROVAL LETTER

Date:	11 August 2022
Validity of Research Approval:	08 February 2022– 30 September 2022 2022/354
Name of Researcher:	S. Loots
Address of Researcher:	538 Oregon Street
	Faerie Glen
	Pretoria East
Telephone Number:	0711006957
Email address:	stefnieloots@gmail.com
Research Topic:	Investigating teachers' conceptualisation of ADHD, neuropsychology, and mathematical interventions in Grade 3 Foundation Phase classes
Type of qualification	Masters
Number and type of schools:	2 Primary Schools
District/s/HO	Gauteng East

Re: Approval in Respect of Request to Conduct Research

This letter serves to indicate that approval is hereby granted to the above-mentioned researcher to proceed with research in respect of the study indicated above. The onus rests with the researcher to negotiate appropriate and relevant time schedules with the school/s and/or offices involved to conduct the research. A separate copy of this letter must be presented to both the School (both Principal and SGB) and the District/Head Office Senior Manager confirming that permission has been granted for the research to be conducted.

16/08/2022

The following conditions apply to GDE research. The researcher may proceed with the above study subject to the conditions listed below are met. Approval may be withdrawn should any of the conditions listed below be flouted:

Office of the Director: Education Research and Knowledge Management
7th Floor, 17 Simmonds Street, Johannesburg, 2001
Tel: (011) 355 0488
Email: Faith.Tshabalala@gauteng.gov.za
Website: www.education.gpg.gov.za

1. *The letter would indicate that the said researcher/s has/have been granted permission from the Gauteng Department of Education to conduct the research study.*
2. *The District/Head Office Senior Manager/s must be approached separately, and in writing, for permission to involve District/Head Office Officials in the project.*
3. ***Because of the relaxation of COVID 19 regulations researchers can collect data online, telephonically, physically access schools, or may make arrangements for Zoom with the school Principal. Requests for such arrangements should be submitted to the GDE Education Research and Knowledge Management directorate.***
4. ***The Researchers are advised to wear a mask at all times, Social distance at all times, Provide a vaccination certificate or negative COVID-19 test, not older than 72 hours, and Sanitise frequently.***
5. *A copy of this letter must be forwarded to the school principal and the chairperson of the School Governing Body (SGB) that would indicate that the researcher/s has been granted permission from the Gauteng Department of Education to conduct the research study.*
6. *A letter/document that outlines the purpose of the research and the anticipated outcomes of such research must be made available to the principals, SGBs, and District/Head Office Senior Managers of the schools and districts/offices concerned, respectively.*
7. *The Researcher will make every effort to obtain the goodwill and cooperation of all the GDE officials, principals, and chairpersons of the SGBs, teachers, and learners involved. Persons who offer their cooperation will not receive additional remuneration from the Department while those that opt not to participate will not be penalised in any way.*
8. *Research may only be conducted after school hours so that the normal school program is not interrupted. The Principal (if at a school) and/or Director (if at a district/head office) must be consulted about an appropriate time when the researcher/s may carry out their research at the sites that they manage.*
9. *Research may only commence from the second week of February and must be concluded before the beginning of the last quarter of the academic year. If incomplete, an amended Research Approval letter may be requested to conduct research in the following year.*
10. *Items 6 and 7 will not apply to any research effort being undertaken on behalf of the GDE. Such research will have been commissioned and be paid for by the Gauteng Department of Education.*
11. *It is the researcher's responsibility to obtain written parental consent of all learners that are expected to participate in the study.*
12. *The researcher is responsible for supplying and utilising his/her research resources, such as stationery, photocopies, transport, faxes, and telephones, and should not depend on the goodwill of the institutions and/or the offices visited for supplying such resources.*
13. *The names of the GDE officials, schools, principals, parents, teachers, and learners that participate in the study may not appear in the research report without the written consent of each of these individuals and/or organisations.*
14. *On completion of the study, the researcher/s must supply the Director: Knowledge Management & Research with one Hard Cover bound and an electronic copy of the research.*
15. *The researcher may be expected to provide short presentations on the purpose, findings, and recommendations of his/her research to both GDE officials and the schools concerned.*
16. *Should the researcher have been involved with research at a school and/or a district/head office level, the Director concerned must also be supplied with a summary of the purpose, findings, and recommendations of the research study.*

The Gauteng Department of Education wishes you well in this important undertaking and looks forward to examining the findings of your research study.

Kind regards

.....

Mr. Gumani Mukatuni
Acting CES: Education Research and Knowledge Management

DATE: 16/08/2022

Office of the Director: Education Research and Knowledge Management
7th Floor, 17 Simmonds Street, Johannesburg, 2001
Tel: (011) 355 0488
Email: Faith.Tshabalala@gauteng.gov.za
Website: www.education.gpg.gov.za