

# **The blurred line between Mathematical Anxiety and Dyscalculia: A Case Study for the Namibia Open and Distance Learning Sector.**

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## **Abstract**

There is an increasing global emphasis on ensuring inclusive and equitable quality education and promoting lifelong learning opportunities for all, particularly in the era of the 4th Industrial revolution. However, how is this possible for adult learners to accomplish their lifelong learning endeavors if they are struggling to pass subjects like Mathematics at higher learning institutions? Mathematics is one of those subjects which most of us have a natural in-born fear of, and our academic performance is negatively affected by this fear and anxiety that is associated with it. The aspect of Dyscalculia, a learning disability that is associated with Mathematics, has never been researched within the Namibian context. Since very little is known about this Mathematics learning disability, it is almost impossible for early identification and screening to take place at Namibian schools and Universities. This lack of early identification and screening not only affects the individual's academic performance, but also their employment prospects and lifelong learning endeavors. Against this background, this case study will focus on eliminating the misconceptions related to Mathematical anxiety and Dyscalculia as a learning disability and propose appropriate Mathematics learning support strategies. The findings will be presented and the case study will enable the researcher to create awareness about Dyscalculia and the importance of early identification and screening at Namibian Open and Distance Learning institutions. This desktop study is not solely focusing on one Open and Distance Learning institution within Namibia, but rather provides a holistic overview of the challenges that the Namibian Open and Distance Learning sphere is facing currently, particularly with regard to Mathematics, and how we can address this.

## **Key Words**

Dyscalculia  
Mathematical Anxiety  
Namibia  
Open and Distance Learning  
Adult Learners  
Learning disability

## **Introduction**

When it comes to Mathematics and the importance thereof as a scientific discipline, it is important to understand the dynamics surrounding Mathematics. One of the crucial dynamics surrounding Mathematics is the competency thereof. As adults, our career expectations often require lifelong learning. These lifelong learning programs are often accompanied by dreadful Mathematics as part of the curricula. The application of Mathematical concepts is often stressful for adult learners and brings about emotions like fear and anxiety. The researcher suspects that this fear could be linked to Mathematics Anxiety or possibly the Mathematics learning disability, Dyscalculia. Both of these phenomena (Dyscalculia and Mathematics Anxiety) led the researcher to believe that there might be a blurred line between Mathematics Anxiety and Dyscalculia and the absence of early identification and screening might have detrimental consequences on the individual and our Namibian economy. Dyscalculia is a learning disability which is uncommon in Namibia (researcher's own opinion), however, the low progression rate in Mathematics in Open and Distance Learning is a cause of concern and one which warrants additional empirical research.

## **Background**

The researcher, being a lifelong learner herself (and not a Mathematical subject-matter expert), has often had to face her fear of dealing with Mathematics as part of her lifelong learning endeavors and has often a time chosen to rather enroll for subjects that require less Mathematics engagement. This phenomenon has driven the researcher to investigate whether other Open and Distance Learning (ODL) learners also encounter the same problem(s) and/or preferences when it comes to Mathematics. This inquiry has led the researcher to come across a learning difficulty that is associated with Mathematics, called Dyscalculia. The signs and symptoms of Dyscalculia are very similar to the fears that the researcher faced with Mathematics (although to a less intense degree). When it comes to the Open and Distance Learning (ODL) academic spectrum, the researcher is of the opinion that academics observe the prevalence that is associated with Mathematics (for example students generally do not like the subject and/or there is a poor performance associated with it), however, they remain oblivious.

## **Statement of the problem**

This study attempts to explore the characteristics and challenges that are associated with Mathematics Anxiety and Dyscalculia.

## **Purpose of the study**

The purpose of this study is to outline the difference between Mathematical Anxiety and Dyscalculia and suggest relevant learning support strategies to support Open and Distance Learning students with Mathematics Anxiety and/or Dyscalculia in Namibia.

## **Research Paradigm/Method**

The researcher conducted a Case study (Interpretive, Single-Case Design) on literature (peer-reviewed articles based on empirical research) relating to Learning difficulties that are associated with Mathematics, with particular emphasis on Mathematical Anxiety and Dyscalculia. The desktop study was conducted using search engines such as Google Scholar and Elsevier, with the key words such as Mathematics Anxiety, Dyscalculia, higher education, open and distance learning, Namibia, Africa, Mathematics learning difficulties, and mathematics learning support.

This online literature search has yielded little results on Dyscalculia and the prevalence thereof within the Namibian context (inclusive of Open and Distance Learning) and has led the researcher to rely on research that was conducted in our fellow African states (South Africa, Zimbabwe, Cameroon, and Nigeria) and international contexts (the United States of America and the United Kingdom).

## **The relevance of Mathematics as a scientific discipline**

When it comes to outlining the relevance and importance of Mathematics for any national economy, researchers (Aremu and Taiwo, 2014; , Nfon, 2019); Park, 2015; Mokotjo, 2017) state that Mathematics is a desirable commodity (Nfon, 2018, p. 22) that is critical to the development of any nation (Aremu and Taiwo, 2014, p. 113). Mathematics can be considered to be a key role player within the Sciences spectrum since it forms the basis for scientific and technological innovations (Aremu and Taiwo, 2014, p. 113-114). Therefore, being numerically competent is considered to be a basic life skill that may affect future lifelong learning and career opportunities (Mokotjo, 2016, p.36-37; Park, 2015, p.1-2). Mokotjo (2017) and Mavesere (2014) reiterated the importance of Mathematics in society, by stating that “ *Mathematics has a direct impact on the socio-economic status, self-esteem and identity of an individual*”(Mokotjo, 2017, p. 35-36) and is fundamental to independent living, employment opportunities and an individual’s socio-economic status (Mavesere, 2014, p.8).

When it comes to the importance of Mathematics on a national scale, research suggests that adult learners generally lack basic Mathematics skills and get anxious at the thought of taking a compulsory Mathematics class (Dowker et al, 2016, p. 45). Mathematics is premised on certain foundational, pedagogical and congenital aspects, and is regarded as a science of structure that consists of multiple components (numerical, geometric and graphical relationships) that has evolved from counting, measuring and describing shapes and objects (Nfon, 2018, p. 22; Dowker et al, 2016, p. 2; Mokotjo, 2017, p. 37-38). Mathematics is dependent on various cognitive abilities (for example the short-term memory, working memory, visuospatial skills and language)(Mokotjo, 2017, p. 46),

therefore memory and the memorization of Mathematical facts is regarded as a crucial aspect (Mokotjo, 2017, p. 37-38) for Mathematical competence.

When it comes to lifelong learning and professional development aspects, Mokotjo (2017, p.36-37) is of the opinion that the high unemployment rate and increase in poverty within South Africa may be contributed by poor Mathematical competence. This trend (the low performance in Mathematics at schools and universities) could be compared to our Namibian context as well. It is important for educators, policymakers and implementers alike to be cognizant of the impact of numerical competence on our national economy since research shows that people who lack numerical competence are twice as likely to be unemployed (Mokotjo, 2017, p. 38). The importance that is associated with Mathematics is also stressed by countries like the United States of America, where researchers like Park (2015, p.1) states that the “*United States of America also highly regards Mathematical proficiency as one of the vital components that are essential for individual fulfillment, active citizenship, and career readiness*” (Park, 2015, p.1).

### **The challenges associated with Mathematics**

Whilst having a brief overview of the foundational and congenital aspects of Mathematics as a science discipline, it is also important to be aware of the emotions and challenges that are associated with Mathematics. Some of the emotions are anxiety (Dowker et al 2016; Mokotjo, 2017 and Mavesere, 2014), frustration (Mavesere, 2014), low interest (Nfon, 2018; Mokotjo, 2017) and a sense of unease or insecurity (Mavesere, 2014), with the primary focus being [Mathematics] anxiety.

According to Dowker et al (2016, p. 1), “*Mathematics anxiety has been defined as a feeling of tension and anxiety that interferes with the manipulation of numbers and the solving of Mathematical problems*” (Dowker et al 2016, p. 1) and can also be termed Mathophobia (Mavesere 2014, p. 25; Dowker et al 2016, p. 1-2). Researchers like Dowker et al (2016, p. 4) are of the opinion that Mathematics anxiety consists of different components, namely the affective (nervousness and tension) and the cognitive (worry and fear)(Dowker et al 2016, p. 2, 4). This anxiety can lead to avoidance and overloading of the working memory (Dowker et al 2016, p.1), thus resulting in a low performance within Mathematics (Dowker et al 2016, p.1). What is evident is that researchers like Dowker et al (2016, p. 2) clearly state that “*Mathematics is known to elicit stronger emotional reactions (especially anxiety), than most other academic subjects...and can be attributed to pre-existing difficulties with Mathematics and to social factors*” (Dowker et al 2016, p.2-3). This fact supports the notion (the fear that is associated with Mathematics) that this research is premised on.

### **Dyscalculia**

When it comes to pinpointing the exact origins of Dyscalculia as a learning disability, researcher like Mokotjo (2017) state that the term Dyscalculia was first introduced by the Czechoslovakian psychologist Ladislav Kosc in 1974 (Mokotjo, 2017, p.27). Researchers like Mokotjo (2017) also concur that Dyscalculia has been in existence for a long time, although little research has been conducted about the phenomenon (Mokotjo, 2017, p. 46). Mokotjo (2017) and Dowker et al (2016) provided critical information in terms of Dyscalculia prevalence, which ranges between five percent (5%) to eight percent (8 %) globally (Mokotjo 2017, p.27), while Dowker et al (2016) estimates that the prevalence rate for Dyscalculia (amongst higher education students) could be as high as eleven percent (11%) (Dowker et al 2016, p.3). Dowker further reiterates that sixty-eight percent (68%) of students that are enrolled for Mathematics at higher learning institutions experience high Mathematics anxiety and therefore the researcher regards this as a significant problem that requires urgent attention and academic support interventions, especially within the context of Open and Distance Learning within Namibia.

Dyscalculia is a very complex Mathematics learning disability. Research shows that there are different types and levels of Dyscalculia. Mokotjo (2016) states that there are three (3) levels of Dyscalculia, namely biological (genetic factors and brain conditions that affect the procedural, semantic and visuospatial memory), cognitive and behavioral Dyscalculia and included three (3) difficulty sub-types, namely procedural, semantic and visuospatial (Mokotjo 2016, p.33, 169-170). Other researchers like De Visscher and Noël (2013) simply makes reference to two (2) profile types of Dyscalculia, namely Dyscalculia and Developmental Dyscalculia (a deficit in cognitive processing resulting in a severe, persistent learning disability that concerns Mathematical skill) (De Visscher and Noël 2013, p.50-51). Researchers like Lewis and Lynn (2018, p.22) are of the opinion that Dyscalculia is internally and biologically based, while Mavesere (2014) also offered another perspective with regard to the classification of Dyscalculia. According to Mavesere (2014), there are four (4) types of Mathematical difficulties, which entails Acalculia, Dyscalculia, difficulties with Mathematics in general as well as Pseudo-Dyscalculia (Mavesere 2014,

p.2). In addition to this, Mavesere (2014) also identified the sub-types of Dyscalculia as being linguistic difficulties, procedural difficulties, automation difficulties, metacognitive difficulties and attentional difficulties (Mavesere 2014, p.52). This is interesting to note since the researcher previously thought that learning difficulties that are associated with Mathematics hardly (or rarely) relate to language proficiency. Mokotjo (2017, p.27) is of the opinion that Dyscalculia is perceived as a structural Mathematical disability or congenital disorder that originates from the brain or which affects parts of the brain that is associated with the application of Mathematics. For the purpose of this research, the researcher will solely focus on Mathematics Anxiety and Dyscalculia, excluding the sub-types.

### **The blurred line between Mathematics Anxiety and Dyscalculia**

By looking at the facts stated above, it might not be uncommon to confuse one phenomenon with the other (Mathematics Anxiety versus Dyscalculia), since similar characteristics overlap (or are resultant of the other). For example, both Mathematics Anxiety and Dyscalculia evoke certain emotions (anxiety, fear, a sense of unease or insecurity and low motivation) (Mavesere 2014, p.55; Aremu and Taiwo 2014, p.114, Mokotjo 2016, p.63) and these emotions can sometimes be a result of past experiences that are associated with Mathematics or the lack of knowledge about Mathematical learning difficulties amongst students and academics (Lewis and Lynn 2018, p.2).

Secondly, both entail automation and language processing challenges and may affect the attitude of the student towards Mathematics as a scientific discipline ( Mavesere 2014, p. 22; Dowker et al 2016, p. 2; Nfon 2018, p.22; Mokotjo 2016, p.63). According to Mavesere (2014, p.22), “*people with linguistic difficulties will often find it challenging to grasp mathematical vocabulary terms, thus making it difficult for such individuals to understand ..., encode and represent Mathematical information*” (Mavesere 2014, p. 17, 22). The researcher is of the opinion that this is important to note since some individuals might only assume that Mathematics Anxiety and Dyscalculia relates to mathematical concepts and the application thereof, and might exclude the linguistic competence aspect thereof. What is unique with Dyscalculia, is that Dyscalculic students may also experience Visual-Spatial difficulties which makes it hard for Dyscalculic students to visualize patterns (including reversals and substitutions), copy information, follow mathematical steps and/or formulae, remember signs and/or symbols (Mavesere 2014, p.23), have a poor sense of direction and problem-solving skills, experience difficulty in basic computational skills, money concepts and estimation- and proportion-related tasks (Mokotjo 2017, p.28; Mavesere 2014, p.19, 52) and more advanced Mathematical applications (Mavesere 2014, p.16). When it comes to Dyscalculia in adult learners, there are also some characteristics and challenges. Dyscalculia in adults manifests itself in the form of finger counting, the lack of number sense of numerosity above 1000 and failing to apply division to higher-order mathematics (Mavesere 2014, p. 19, p.27).

All of this information seems pretty gloomy when it comes to a Dyscalculic learner’s lifelong learning endeavors, however, research suggests that Dyscalculic students still possess normal intelligence in non-Mathematics related subjects (Mavesere 2014, p16; Cuskelly & Farragher 2019, p.153 and Mokotjo 2017, p.31). With this being said, the researcher is of the opinion that academics should not assume that students who perform poorly in Mathematics will also perform poorly in another academic subject. We should also be mindful that Mathematics consists of various components (Dowker et al 2016, p. 2) ), therefore the researcher also wishes to caution that students may have challenges with certain aspects of Mathematics and not the subject as a whole.

Another common characteristic of both phenomena (Mathematics Anxiety and Dyscalculia), is the aspect of age. Researchers like Dowker et al (2016, p.1) coupled the age aspect with attitude. According to Dowker et al (2016, p. 1) an individual’s attitude towards Mathematics deteriorates with age (Dowker, et al 2016, p. 1, p.9) which has negative implications on the mathematical competence of an individual. Dowker et al (2016, p.9) are of the opinion that Mathematics anxiety is closely related to Mathematics performance and this performance, in turn, is affected by age (Dowker et al 2016, p.9).

Fluency in Mathematics is another recurring theme that is associated with Mathematics Anxiety and Dyscalculia. Researchers like Dowker et al (2016) and Mokotjo (2016) both agree that fluency in Mathematics can have an impact on Mathematical anxiety (Dowker et al 2016, p.4; Mokotjo 2016, p.161). The researcher concurs that fluency in Mathematics will have an impact on Mathematics and can be regarded as an attributing factor when it comes to Dyscalculia.

### **Learning support for students with Mathematical Anxiety and/or Dyscalculia**

The researcher classified the learning support mechanisms and/or strategies into two (2) groups, namely **Elementary (Grass root level) Mathematics Learning Support (EMLS)** and **Technological Mathematics Learning Support (TMLS)**.

According to the researcher, **Elementary Mathematics Learning Support (EMLS)** is the most crucial level of support that can be offered to students who suffer from Mathematics Anxiety and/or Dyscalculia. Learning support mechanisms such as early identification and screening for specific learning difficulties (Mavesere 2014, p56; Dowker et al 2016, p. 10) are regarded as a crucial step as part of the ELMS. However, researchers like Mavesere (2014) suggested that further testing should be conducted by a psychologist, medical doctor or neurologist, in order to ascertain a definite diagnosis (Mavesere 2014, p.53). Some of the Mathematics and/or Dyscalculia screening tools that were suggested are the Dyscalculia Screener (an outdated diagnostic tool that assesses children's mathematical achievement and numerical ability, however it does not consider the age of the student being tested)(Mokotjo 2017, p.5-6), the Davis Dyslexia and Attention Deficit Hyperactivity Disorder (ADHD) assessment (an alternative to the Dyscalculia Screener) (Mavesere 2017, p.5-6), the DyscalculiUm screening tool (the most effective tool to be used for screening adults)(Mavesere 2014, p. 13-14) and the Mathematics Anxiety Research Scale (or MARS test as it is commonly known)(Dowker et al 2016, p.4-5).

Currently, there is no Mathematics learning disability screening (using any of the above mentioned diagnostic assessment tools) offered at Open and Distance Learning institutions within Namibia, however other services like counseling services are offered. The purpose of these counseling services is to identify the academic challenges that students might experience and referrals to Educational Psychologists and/or social workers are sometimes offered. However, the researcher is of the opinion that these counseling services might be effective as a short term intervention, but the problems associated with Mathematics might persist in the absence of early identification and screening for Mathematics learning disabilities. Mathematics Anxiety and Dyscalculia can be treated (Mavesere, 2014, p.55), however, this treatment is profoundly reliant on the diagnosis.

Additional ELMS can also be provided in the form of Mathematics Learning Support Centres (Rosic 2016, p.43), self-reflection (that will enable students to focus on their successes as opposed to their failures)(Aremu and Taiwo, 2014, p.113-114) and student profiling through the use of a learning management system called '*Assistive Learning Environment*' (ALE) (Ahmada and Mutalibb 2015, p4). According to Ahmada and Mutalibb (2015, p4), ALE is an interactive learning management system that consists of adaptable pedagogical strategies that in turn is able to analyse the learner's behavioural profile and learning style in order to customize the student's learning experiences in Mathematics (Ahmada and Mutalibb 2015, p4). Ahmada and Mutalibb (2015, p.4) also suggested the use of '*Technological Persuasive Pedagogy*' in order to persuade and encourage learners in Mathematics to change their [negative] perspectives and attitude towards Mathematics (Ahmada and Mutalibb 2015, p.3-4), however this also warrants future empirical evidence in order to prove its effectiveness and relevance in dealing with Mathematics Anxiety and/or Dyscalculia.

### **Technological Mathematics Learning Support (TMLS)**

When it comes to technological support, the researcher is of the opinion that you first need to consider the audience that you are catering for as well as their level of technological competence. Therefore, the technological support should consider the age, preference, competence associated with technology (especially educational technology) and the availability of technology or broadband services.

Some of the technological support strategies and/or mechanisms that were suggested entails gaming software (Mokotjo 2017, p.3; Mavesere 2014, p55; Nfon 2018, p.22 and Park 2015, p. 8-10), for example '*The Number Race*'(developed for Dyscalculic students by Wilson and Dehaene from New Zealand in 1999)(Mavesere 2014, p.55), '*e-WayCOOL*' (interactive multimedia technology that is used to teach Mathematics to primary school children), '*MyLINUS*' (which is a reading tool that is specifically used in Malaysia) and '*Math Explorer*' (which is premised on persuasion and guided instruction) (Ahmada and Mutalib 2015, p.3-4). The choice of software will depend on applicability, relevance, and usage for the end-user (the adult student) and caution in its use should be exercised at all times (Rossell 2015, p. 7). The '*bring your own device*' initiative (Rossell 2015, p7-8) was also suggested in order to ensure access and inclusion as part of the learning support strategy. However, when it comes the use of personal devices in educational settings, we (as educators, academic administrators, and students) need to be guided by relevant policies and procedures in order to avoid exposing our students to external dangers (for example theft) or personal liability for Open and Distance Learning institutions. We also need to consider the

aspect of critical thinking and higher-order thinking skills when it comes to the use of educational technology (Park 2015, p.29).

In countries such as Namibia, we have to consider the availability and reliability of broadband services and the availability of electricity (especially within our rural or remote areas), before we can even consider the aspects such as applicability, relevance, and usage when it comes to the use of technology-enabled Mathematics learning support. Another aspect that we need to consider, is the issue of policies addressing the usage of technology as part of the learning support strategy. This issue is important, especially within the context of Open and Distance Learning, since our teaching and learning practices are guided (or informed) by institutional and national educational policies. Regardless of the learning support strategy (elementary or technological), it is important to consider that the commitment (by the teacher and student) is crucial in determining the success of the Mathematics learning support intervention.

### **Shortcomings that were not addressed in the Literature Review**

Although the literature review yielded favorable results in terms of being equipped with an understanding surrounding Mathematics Anxiety and Dyscalculia and the challenges and opportunities associated with it, the researcher is of the opinion that certain aspects relating to this research were not addressed. Some of these aspects include the lack of empirical research relating to Mathematics Anxiety and the impact on Open and Distance Learning (especially within our African context) and the prevalence rates of Dyscalculia within Namibia.

### **Conclusion**

In conclusion, the researcher provided an overview of learning difficulties that are associated with Mathematics, with particular emphasis on Mathematics Anxiety and Dyscalculia and discussed the characteristics and challenges that are associated with it. The researcher also provided an overview of learning support strategies (elementary and technological) that could be used to support adult learners in Open and Distance Learning within Namibia.

Considering these common factors (attitude, emotions, age and performance), it is not uncommon for educators to confuse the two (2) phenomena (considered the blurred line by the researcher) and possibly have a mis-diagnosis of either (Mathematics Anxiety or Dyscalculia). It is only through early identification and screening that appropriate learning support strategies can be employed in order to eliminate this blurred line that exists between Mathematics Anxiety and Dyscalculia.

### **Recommendations**

In order to address some of the shortcomings highlighted in this study, the researcher recommends that a Mathematics Anxiety and/or Dyscalculia Community of Practice (MADCoP) should be established within Namibia. The researcher is of the opinion that this Community of Practice will inform policies (or the development thereof) and will advocate for the implementation of adequate and appropriate learning support strategies (which includes early identification and screening and the use of educational technology and/or assistive devices) to support students in Open and Distance Learning institutions within Namibia.

The researcher is also of the opinion that it is imperative to include Education 4.0 (the fourth technological-driven industrial revolution) as part of additional research focus areas, since it will have an impact on our Mathematical learning support strategies offered at Namibian Open and Distance Learning institutions.

All of the afore mentioned future research focus areas will enable Namibia to boost its national and international Open and Distance Learning research output and reiterate the importance of Mathematics and numerical competence within our Namibian society.

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