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Weathering the storm: Learning strategies that promote mathematical resilience

Authors:
Vuyisile L. Khumalo[1]
Surette van Staden[1]
Marien A. Graham[1]

Affiliations:
[1]Department of Science, Mathematics and Technology Education, Faculty of Education, University of Pretoria, Pretoria, South Africa

Corresponding author:
Vuyisile Khumalo,
vdyantyie@kayafmmail.co.za

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Most learner achievement studies tend to focus on identifying individual characteristics, ignoring the learning strategies that promote mathematical resilience. The focus of the study is on the assets embedded in an individual and their interplay with the environment. It is expected that resilience plays a deciding role in learners' foreground with the potential to affect learner mathematics achievement in constrained environments positively. This study, framed within the socio-ecological perspective of resilience, explored how disadvantaged learners learn mathematics in a disadvantaged environment in the Further Education and Training band in South Africa. A total of nine (five boys and four girls) Grade 12 learners learning mathematics in disadvantaged environments from Johannesburg West and Johannesburg Central districts were purposively selected and one-on-one semi-structured interviews were conducted with them. This thematic report pays attention to the qualitative phase of a broader study that employed a sequential exploratory design that draws from the work of Vygotsky, Carroll and Skovsmose. The framework focuses on the dynamic interactions between learners and the connection between the home and the school. Accordingly, the findings revealed two interrelated themes, namely foreground and growth strategies. These themes make apparent the connection between the context and the interpretation of the context by an individual as translated into decisional processes. Implications for teachers are discussed.

Keywords: resilience; mathematical resilience; assessment feedback; foreground; learning strategies.

Introduction

In South Africa, senior secondary learner performance remains constrained for most disadvantaged learners (Christie, Butler, & Potterson, 2007). South Africa is glaringly outperformed by much poorer countries in the Southern African Development Community (SADC), such as Mozambique and Tanzania, in respect of mathematics achievement (Hungi et al., 2010; Taylor, 2009). Poor learner performance may very well indicate learning deficits that are likely to perpetuate educational inequalities in the education system. Spaull and Kotze (2015) revealed that the learning gap between poorer learners (that make up about 80% of the population) and learners from affluent backgrounds (that make up about 20% of the population) is in the region of three grade levels in Grade 3 and grows to four in Grade 9. It is thus not surprising that learner performance in mathematics in Grade 12 has been declining steadily by at least 4% from 2013 to 2015 (Department of Basic Education, 2016).

A plethora of literature shines the spotlight on factors driving poor learner mathematics achievement. Prominent factors that have an impact on mathematics teaching and learning have been identified and range from the management of the teaching and learning process (Bush, Joubert, Kiggundu, & Van Rooyen, 2010), language proficiency of learners, particularly English (Howie, Scherman, & Venter, 2008), socio-economic status of learners (Taylor, 2009), teacher content knowledge (Van der Berg, 2015) and teacher to learner factors (Tachie & Chireshe, 2013). To this end, more than 10 years ago, Setati, Chitera and Essien (2009) already argued for research to explore social, interactive factors that may ensure mathematical success. Through the construct of resilience, this study explores one aspect of the resilience factors that may ensure mathematical success.

Literature suggests that resilience is defined differently owing to the discipline within which a researcher is grounded or located. Albeit not exhaustive, Waxman, Gray and Padron (2003) list a few disciplines that use resilience: psychopathology, psychology, sociology, and anthropology, each with its own focus on aspects of resilience. To this end, Ebersöhn (2017) argues that resilience is a process that involves school stakeholders, namely teachers, principals, parents, learners, and district officials who are chiefly geared towards helping teachers to teach and learners to learn. On the one hand, Masten (2015) regards resilience as a dynamic concept that entails the ability to adapt to adversity. On the other hand, Johnston-Wilder and Lee (2010) introduce the idea of mathematical resilience as 'a positive approach that allows people to overcome affective barriers presented when learning mathematics' (p. 1). However, Windle (2011) proposed an overarching definition of resilience as 'the process of effectively negotiating, adapting to, or managing significant sources of stress or trauma' (p. 152). It is a definition that resonates with this study and is thus utilised as an operational definition in this study.

Adaptation requires changing and adjusting behaviour that is geared towards buffering the impact of risk and promoting resilience. In this regard, the study accepts, as an operational definition in this study, the suggestion by Ungar, Ghazinour and Richter (2013) that protective processes are 'those processes that enhance the experience of well-being among individuals who face significant adversity' (p. 340).

Waxman et al. (2003) explained that learner achievement stands to benefit by tapping into resilience as a fluid construct and paying attention to those malleable factors that can make a difference. Malleable factors include those factors that schools and teachers have control over and, over time, have played a critical role in enhancing and improving learner performance as evidenced in school effectiveness research reviews (Purkey & Smith, 1983; Scheerens, Luyten, Steen, & De Thouars, 2007). Crucial in utilising resilience as a construct is the understanding that is explained by Duckworth, Akerman, Macgregor, Salter and Vorhaus (2009) that resilience emanates mainly from three levels: the individual, the family, and the school.

It is a stance that firmly resonates with Martin-Breen and Anderies (2011) that understanding resilience and change 'requires understanding the process and the dynamics within learners and between them and their environment' (p. 13). Understanding resilience at different levels invariably requires the understanding that resilience is interactive and interdependent (Masten, 2015). More importantly, resilience researchers have refocused their research by directly focusing on the competence in children at risk of problematic outcomes (Masten, 2014).

Equally, in the education sector, a move is afoot to focus and concentrate on what learners can attain and maintain, and areas where they excel (Gutiérrez, 2008; Martin, 2012; Mkhize & Nduna, 2010; Setati et al., 2009) despite adversity. In so doing, the focus is on the assets embedded in an individual and their interplay with the environment that can have a profound effect in promoting positive and desirable outcomes or development.

In South Africa, according to Ebersöhn (2016), studies on resilience are fragmented, often are regional and are mostly case studies. As observed by Theron and Theron (2010), resilience studies in South Africa are conceptualised as the product of individual traits or protective resources and, at times, as a product of a person-context transaction. Exploring how disadvantaged learners learn mathematics in a disadvantaged environment requires that this study be firmly located within the person-context transaction. It is an attempt at uncovering the processes of adaptation that learners use to learn mathematics under adverse conditions. In other words, it is uncovering how disadvantaged learners in a disadvantaged environment develop mathematical resilience.

To this end, Ebersöhn (2017) contends that even though schools operate in disadvantaged or harsh conditions, schools need to offer their learners valuable support systems to enhance the teaching and learning situations. In keeping with this belief, Pridmore and Jere (2011) utilised the concept of resilience in Malawi to investigate how to disrupt the patterns of poor learner achievement in a disadvantaged environment by creating circles of support around each learner.

In this instance, members of the community were used to offer encouragement for learning through peers, mentors, and youth club leaders. Although the programme was able to improve the mathematics results of disadvantaged learners, improved motivation, and the capacity for independent learning (Pridmore & Jere, 2011), the study fell short of shedding light on how learners processed the learning experience.

However, Lugalia, Johnston-Wilder and Goodall (2013) implemented an information and communication technology programme in Kenya to learn algebra for all the Form 1 (Grade 8) learners in the school. The authors found that teachers reported progress in learners' three mathematics examinations taken during the course of the school term as well as observable attainment-enhancing behaviours. These three examinations are set at the departmental level but marked by corresponding subject teachers at respective schools. In other words, the examinations are set externally by external examiners. To this end, the authors conclude that learner progress may be attributed to the shift that transformed teaching and learning of algebra that pays attention to the learning experience of the learners.

Although the study by Lugalia et al. (2013) points out the collaborative interaction of elements in the context of the learner, the study was only focused on one mathematics topic in one girls-only boarding school. In South Africa, Mkhize and Nduna (2010) argue further for interventions in disadvantaged schools that focus on enhanced cognitive development and a positive coping style that promotes resilience.

Increasingly, literature is observing a cohort of disadvantaged learners across different education bands that are defying all odds and developing the necessary skills to cope with general academic demands. Diamond, Furlong and Quirk (2016), utilising Grade 4 and Grade 5 learner data in the United States of America, identified a group of Latino learners who showed signs of improving their academic skills development in oral fluency, and verbal and non–verbal cognitive development. In South Africa, Taylor, Van der Berg, Reddy and Janse van Rensburg (2011), using panel data set of Grade 8 learners that took part in Trends in International Mathematics and Science Study (TIMSS) 2002 and then tracked to Grade 12, although surprised by the finding, also observed that disadvantaged schools with disadvantaged learners showed signs of converting their Grade 8 poor learner achievement to a matric pass; in particular, one in five learners were able to convert their poor Grade 8 pass to a Grade 12 pass. Furthermore, Reddy et al. (2016), utilising the TIMSS 2015 Grade 9 results, had this to say:

> We can identify a number of groups, which will be able to accelerate the pace of change with the appropriate support. These groups include learners who achieved scores between 325 and 400 points in no-fee schools. This group represents the immense potential that exists amongst our learners to achieve excellence, given sufficient support. (p. 15)

That said, these South African studies are thin on pointing out the collaborative interactions of elements within the context of the learner in improving their poor mathematics result. Thus, this current study attempts to reveal the processes that learners undertake to develop mathematical resilience and thus improve their poor mathematics results.

Research questions

This study forms part of a broader mixed methods design study that asked the following main question: How do disadvantaged learners learn mathematics in a disadvantaged environment?

The following research sub-questions guide this report:

1. How do learners describe their home environment in their personal aspirations and mathematics achievement?
2. What strategies do learners use to cope with mathematics demands?

Conceptualisation of the study

The initial study utilised a fusion from the work of Vygotsky (1978), Skovsmose (2012) and Carroll's model of school learning as a theoretical framework (Carroll, 1963) in order to explore how disadvantaged learners successfully learn mathematics in a disadvantaged environment. However, this article reports on the contribution of Skovsmose's ideas of foregrounds to make meaning of the data.

Amin (2012) succinctly points out that foreground significantly differs from the psychological perspectives that foreground as an object may be distinguished from its background or as a prominent figure that can be remembered for longer than the background. According to Amin, foreground is paying attention to the future. More importantly, Amin stresses that foreground is intractably related to two types of developments, namely personal and national.

Skovsmose (2012) suggests that showing an interest in learners' foreground is crucial for establishing meaningfulness. According to Skovsmose, 'a foreground is fragmented, partial and inconsistent constellation of bits and pieces of aspirations, hopes and frustrations' (p. 12). Thus, foregrounds are possibilities, aspirations, tendencies, obstructions, and barriers that are formed through the interpretation of the environment and of these possibilities and obstructions. Foregrounds are fragmented, multidimensional, and may be promising or frightening yet collective in nature (Skovsmose, 2012). A closer look at a study by Hernandez-Martinez and Williams (2013, p. 7), particularly Jenni's narrative, illustrates the retrospective and feeding nature of foregrounds. Here, Jenni decides to excel in mathematics because she wants to be different from her family, which is in the medicine sector, and join the financial sector which requires mathematics achievement in school. Similarly, Amin (2012) utilises the concept of foregrounds to illustrate the respective and feeding nature of foregrounds and further makes the point that foregrounds are connected to personal and national development and are shaped by prevailing conditions in the context of the learner. Kacerja (2011) not only confirms the feeding nature of foregrounds but also affirms that learners are likely to be more interested in mathematics if the focus is on things that have a bearing on their future. In other words, foreground is all the concerted efforts to focus one's attention on the future.

In this framework, foregrounds are posited to function in an interactive and connective way between the home and the school. It is expected that a stronger connection between success in mathematics and the learners' foreground has the positive potential to affect learner mathematics achievement. According to Valero, García, Camelo, Mancera and Romero (2012), foregrounds provide a powerful alternative framework that departs from the deficit explanation of learners' disengagement to a framework that recognises the dynamic interactions between the learners' home and mathematics engagement. Accordingly, foreground provides a framework to better understand the dynamic protective processes that promote mathematical resilience in constrained environments.

Methodology

This research report adopts a qualitative approach framed within a pragmatist paradigm. This paradigm 'focuses on "what works" rather than what might be considered absolutely and objectively "true" or "real"' (Weaver, 2018, p. 1286). Morgan (2014) has argued that although pragmatism has been mainly associated with mixed methods research, it can be used in social research regardless of whether that research is qualitative, quantitative, or mixed methods. Morgan goes on to claim that pragmatism is a new paradigm that replaces the older philosophies of knowledge that use ontology and epistemology.

To capture the lived experience of mathematical learners, a one-on-one semi-structured interview was utilised for this purpose. Morse (2015) revealed that a semi-structured interview is designed to elicit rich subjective responses from participants about a particular situation or phenomenon. According to Morse, all the data collected are comparable as participants are asked the same questions. Merriam and Tisdell (2016) point out that the chief purpose of the interview is to obtain a special kind of information that can be used as an exploratory device to identify relationships or even explore deeper into the participant's motivations and reasons for responding the way they do.

Data collection instruments

A one-on-one semi-structured interview schedule was utilised to elicit rich data. An effective interview schedule not only contains meaningful prompts of the phenomenon of interest but also is relevant to the participants (Bearman, 2019). Guided by literature on resilience and mathematical resilience, the study interview schedule contained open-ended questions aimed at eliciting information on the learners' identity, their home and community environment together with their school or classroom. Table 1 provides the questions used in the interview schedule.

Sample

The sample consisted of nine (five boys and four girls) Grade 12 learners that were purposively sampled to provide for relevance, diversity, and depth of understanding (Etikan, Musa, & Alkassim, 2016). These are learners that attend poor schools and face poverty as a distal risk or have failed a grade, at least once, in the Further Education and Training (FET) band. Despite the adversity or threat, these learners have showed some improvement in their mathematics achievement by attaining at least 30% in mathematics performance as a minimum requirement within the FET band. Schools are divided into five quintiles. Quintiles 1 to 3 are classified as no-fee paying schools, while the upper quintiles represent schools that charge school fees. Quintiles are determined based on how poor the community around the school is (Maistry & Africa, 2020).

TABLE 1: Interview questions.

Category	Questions
Identity	How do you describe yourself?
	How would you describe your high school mathematics journey?
	What are your future plans?
Home and community	How would you describe your relationship with your family?
	How do you describe your home and community environment in relation to your mathematics learning?
	What activities do you do with your family?
	Which of these activities do you consider important for your mathematics learning?
	What role do your family and community members play in your mathematics learning?
School and classroom	Why did you choose this school?
	How would you describe your relationship with your mathematics teachers in the school?
	Why did you choose mathematics as a subject?
	What role do your friends and teachers play in your mathematics learning?
	What is your ideal mathematics classroom?
	How do you manage to cope with mathematics demands?
	If you were to ask for support, what kind of support would you want and from whom do you think you can get that support?
	What is your advice to mathematics teachers who want to improve learner mathematics performance?
	Equally, what would you say to those learners who want to improve their mathematics achievement?

Table 2 presents the spread of schools and participants across quintiles. Participants were drawn from two educational districts, namely Johannesburg West and Johannesburg Central districts. These learners were recommended for this study by their respective educators. Educators came to know of this study in an information sharing meeting held once a term (three academic months) under the auspices of the Johannesburg West District Office and Johannesburg Central District Office, which monitor and support schools in mathematics and other subjects. Thus, three educators representing three different schools from Johannesburg West district and two educators representing two schools from Johannesburg Central district recommended learners for this study. The researchers compared previous mathematical performance from the school learner assessment schedule. Learner assessment schedules are official Gauteng Department of Education records that track the learners' performance per term per grade. These records are also utilised to produce the final learner report card, which determines whether a learner repeats a grade or proceeds to the next grade when all minimum requirements to proceed are met.

Data analysis

This study utilised thematic analysis as a fitting data analysis method for exploration (Onwuegbuzie & Teddlie, 2003) of how disadvantaged learners in a disadvantaged environment learn mathematics in the FET phase. Thematic analysis was done through Atlas.ti version 8.

Braun and Clark (2012) define thematic analysis as 'a method for systematically identifying and offering insight into patterns of meaning (themes) across a data set' (p. 57). The study also followed the six guiding phases to thematic analysis as espoused by Braun and Clark (2006, 2012). However, Braun and Clark (2006) also caution viewing these six phases (familiarising yourself with the data, generating initial codes, searching for themes, reviewing

TABLE 2: School and gender breakdown of participants.

School	Quintile	Number of participants	Gender	
			Male	Female
A	1	1		1
B	3	1	1	
C	3	2	2	
D	3	3	1	2
E	3	2	1	1

potential themes, defining and naming themes, producing a report) as a linear model as data analysis is a recursive process of generating initial codes, searching for themes, reviewing potential themes, defining and naming themes, resulting in producing a report.

Trustworthiness

Trustworthiness of this study was enhanced by the five trustworthiness criteria, namely credibility, transferability, dependability, researcher's worldview, and confirmability (Anney, 2014; Tracy, 2010). Credibility was enhanced by affording some learners the opportunity to verify the accuracy of the interview transcripts, through member checking as influenced by time and participants' literacy levels (Carlson, 2010; Creswell & Miller, 2000). Thick descriptions of the methodology, and the study context as used in this study provide for the study transferability or generalisability (Anney, 2014; Carcary, 2009). Anney (2014) suggests that dependability may be enhanced through an audit trail. Thus, to cater for dependability, the study ensured that an audit trail, that includes the interview schedule, audio recording and transcripts, is kept safe. All the data are kept at the University of Pretoria.

According to Creswell and Miller (2000), the insider perspective is intrinsically embedded within the worldview or paradigm assumptions held by the researcher. One of the researchers attended school in a similar environment to the learners in this study and is also teaching mathematics in the FET band under similar conditions. The researcher is considered a member of the group and thus an insider. Thus, the researcher provides an insider's view and reflexivity as the researcher reflects on the cultural, social, and historical forces at play that may shape and reshape the interpretation of the data set. Confirmability was ensured through a methodological description that provides the reader the opportunity, through an audit trail, to assess the extent to which the emerging constructs are grounded within the data (Anney, 2014; Ghafouri & Ofoghi, 2016).

Ethical considerations

Ethical clearance was applied for and granted by the University Research Ethics Committee. After the granting of the clearance certificate by the University Research Ethics Committee, institutional permission was sought from and granted by the Gauteng Department of Education. Through school principals, school governing body permission was sought as well as parental consent. Lastly, learner consent was sought for those learners over the age of 18. As for learners below 18 years, parental consent was deemed sufficient in this study. These learners' interviews were conducted in their respective schools with either a teacher or the principal present to ensure protection. All the participants were not asked to identify their real names; thus, pseudonyms were used to protect participants in the report.

Results

From the thematic analysis of the semi-structured interviews, two interrelated themes with respective sub-themes were constructed. These themes are *foreground* and *growth strategy*. These themes make apparent the connection between the context and the interpretation of the context by an individual as translated into decisional processes.

Foreground

Two features are important in the formation of foregrounds, the context, and the subjective interpretations of the context (Skovsmose, 2012). Data analysis makes visible the connections between the context as perceived by learners and their respective interpretations of the context. Eight learners described their home or community environment as not conducive, noisy, ignorant, and harmful, thus they spent more time in school learning mathematics as illustrated by the following narratives:[1]

> 'I would say my environment is not conducive there is too much noise, there is too many activities going on, there is not a quiet place where I can sit down and study and practice maths. … I would say my, my environment is not conducive for me to learn mathematics that's why I take time to learn at school.' (Nomsa*)

> 'Ayi [*not*] supportive.' (Pamela*)

> 'It's not helpful, iyo, iyo, like, every time even now, if I can go back home, like I will find people drinking alcohol, drug abuse, like, don't have any, like, don't see any inspiration there, like you don't get any inspiration. There is noise.' (Sipho*)

> 'Around i-community yami abantu bastereotyped ukuthi i-maths inzima, bafuna ukwenza izinto ezi-easy, kahle bona bafuna i-easy life. [*Around my community the people are stereotyped to accept that mathematics is difficult and thus take the easy way out*].' (James*)

> 'Like the community members, they are not aware.' (Busisiwe*)

Even though the learners' environment is harmful and non-supportive, teachers are expected to play a pivotal role in the formation of the learners' foreground. Teachers are not only ideally positioned to influence mathematical learners' foreground (Skovsmose, 2005), but also the teacher's outlook is implicated in the foreground of the learner (Amin, 2012). More importantly, teachers are an accessible human resource that is crucial in shaping learning opportunities and the development of mathematical resilience (Gholson & Martin, 2014). Embedded within these narratives is the capacity of the learners to interact with the available resources (human resources) that the environment provides as they navigate their way to development of mathematical resilience (Ungar, 2008). This study's results point to teachers as a source of inspiration in the formation of the learners' foreground, as evidenced in these narratives:

> 'My teachers, when they speak about how they started their journey in mathematics and how their journeys of life started, it motivates me to say that, even though I am not at the place where are I would like to be right now in mathematics, but I can actually get where I wanna go.' (Nomsa*)

1.Pseudonyms used to protect the identity of learners and educators.

'u-Sir Mahlangu* wangibuza, u-Sir wangibuza ukuthi why ama-marks wakho wa-last year abheda, while la-uphefome kahle, ngamutshela ukuthi ahi, Sir ukuthi bengingafundi kahle ini ini, all that stuff, mara khona manje ungibonisile ukuthi nginga yeki i-situation yase khaya ukuthi ingidifine ukuthi ngingubani, mele ngispane ngiyenzeni. [*Sir Mahlangu* asked me why my marks are better than last year, then I told him that I was not studying and stuff like that, he then showed me that my home situation should not define me and I should just work hard.*].' (James*)

'They [*teachers*] don't want a learner who struggles in class, when you struggle, they ask you where you don't understand and what went wrong because they seem selfish in a way cause like they tend to care about us.' (Mandla*)

'Okay, firstly, uh, as Mr Majola* would say that your attitude determines your altitude, meaning that I tell myself that okay, you know what Vivian this is it.' (Vivian*)

Nonetheless, one participant, Busisiwe, indicated that a former learner represented a source of inspiration:

'He [*former learner*] used to study a lot last year so I sort of aspired; I wanted to be like him.' (Busisiwe*)

According to Skovsmose (2012), foreground entails the individual interpretation of the opportunities that the political, economic, and social context presents. These interpretations are expressed as intentions, hopes and aspirations that focus on the future. All the participants in this study expressed their desire to pursue a future career that involves mathematics. Participants' future plans included careers such as cardiologist, accountant, electrical engineer, and child psychologist:

'Well, my future plans are to study economics, so I would need a lot of mathematics especially financial mathematics.' (Nomsa*)

'I wanna be an economist. So, economics involves statistics, so I learn that statistics is maths.' (Mandla*)

'I plan to pursue a career in, uh, financial, uh, accounting science.' (Busisiwe*)

'Ke batla go phasa ka go bane ke batla go ba cardiologist. [*I want to pass because I want to be a cardiologist.*]'.' (Pamela*)

'Future plan is to go study electrical engineering.' (Sam*)

'I want to become a child psychologist, a child and teenage psychologist.' (Vivian*)

Hernandez-Martinez and Williams (2013) revealed two major motives for doing mathematics that include the use value (with respect to pursuing a career or vocation that uses mathematics, for instance mathematics teacher) of mathematics and the exchange value (the need to do mathematics as a prerequisite for a qualification) of mathematics or providing entertainment. Similarly, in this study, Busisiwe and Mandla, for instance, depict the use value of mathematics as they plan to pursue careers in accounting and economics which use mathematics as a base while Vivian reveals the exchange value of doing mathematics.

Mathematical learners' expression of their hopes is seen as a personal expression of the sense of purpose (Ungar, 2008). Results indicate that participants have a greater awareness that their future career choices need mathematics. It seems that such awareness is predicated on their research efforts into the requirements of their individual future careers:

'So obvious ngaqala ngayenza i-research yami, kwatholakala ukuthi, okay ama-accountant awa, abantu abayenza i-commerce. [*So obviously I started by doing my research and then I found that accountants are people who do commerce.*].' (Jack*)

While the participation process in mathematics learning is facilitated largely by teachers, the willingness by learners to participate in their own process of learning mathematics is equally important (Gorgorió & Planas, 2003). The willingness is seen through the identification of the source of change in the learners' participation in the learning of mathematics. Thus, mathematically resilient learners can identify, access, utilise and connect with competent others (Masten & Coatsworth, 1998).

Results of the semi-structured interviews indicate the varied sources of change that a mathematically resilient learner attributes their turning point to. These sources of change are a chance encounter with a teacher, the learner's attitude, or even repeated failure. James provides an indication of a chance encounter with his mathematics teacher and says:

'Grade 11 then Sir, Sir there was a Sir e-sikoleni, who told me ukuthi, why am I, why am I running nama chickens, while I should be flying nama eagles, so I started realising, ukuthi, Okay, I can do this. [*My Grade 11 teacher said why am I running with chickens when I should be flying with eagles, then I started realising that I can do this.*].' (James*)

Nomsa attributed her turning point to her attitude towards the subject:

'Uh, I would say my attitude was my change.' (Nomsa*)

Repeated failure was described by Jack as a source of his inspiration rather than a risk factor. Jack illustrates his resilience in that he endured prolonged failure, but did not change mathematics for other subjects in school or even drop out:

'Is when like, I started like, to, to fail over and over again, like ngaqala ngafeyila for, u-Grade 10 wami, ngafeyila, ngafeyila u-Grade 10 kayi - two, which meant ngumiriphithe kayi-three. [*When I started to fail my Grade 10 twice, which meant that I had to do it three times.*].' (Jack*)

Busisiwe depicts a learner who negates the widely held stereotype that mathematics is difficult and channels her mind to stick with the subject:

'I think most of the time we listen to what other people tell us, they always say mathematics is difficult, and then you channel your mind to that mathematics is difficult, so it got to me that, to a point where I was like, I want to see this mathematics, I want to try.' (Busisiwe*)

Other than that, most of the learners attributed their turning points in mathematics to an awareness that their future plans require mathematics, as evidenced by the following:

'I think when you reach matric and Grade 11, there's, there is a realisation that you see that most of the times maths, maths is used in every university.' (Mandla*)

'I'm in Grade 12 now, I want to finish school with a higher grade in maths so that I become somebody in life.' (Sam*)

'I told myself that if I, I don't improve, nothing will go according to my plans or my, my goals won't be achieved, so I just decided from that moment that I have to do the right thing, focus on my school work and forget about, like everything.' (Sipho*)

'My turning point started here in matric, seeing that some other topics I can tackle them much more easily than others and then I just thought that, I saw actually that, okay, this is it I am going to pass maths this year other than the other years.' (Vivian*)

Growth strategy

For a person to manage their life circumstances, a person needs a high level of forethought (as the process and beliefs that occur before efforts for learning are deployed) to wield anticipatory adaptive control. Self-efficacy is an aspect of self-management that fuels the quality of success or performance (Bandura & Locke, 2003). A person's self-efficacy tends to regulate human function through cognitive, motivational, affective, and decisional processes (Bandura & Locke, 2003). Dweck (2012) has pointed out that learners with a growth mindset (the belief that intelligence is not fixed) tend to embrace challenges, persist in the face of adversity, view effort and study strategies to learn and use feedback to improve their achievement. Thus, beliefs are to be accompanied by decisional processes. Most participants in this study described using assessment feedback not only to reflect on their study techniques but also as an encouragement that boosts their confidence in their understanding of mathematics to get ready for their final examinations:

'They motivate, they motivation. Firstly, you fail you realize that, when you fail you feel like I have to push myself, I have disappointed myself, and then you work based on that, okay, you look at the paper, okay, where did I go wrong, where do I have to put more effort into?' (Busisiwe*)

'Ngizofuna ukubona ukuthi ngibhede kuphi and the ngilungise ama-misteki wami, so that ngizobe ready for i-finali. [*When my results come back, I want to see where I went wrong, where my mistakes are so that I can get ready for the final examination.*].' (James*)

'Uh, they, they boost my confidence in maths because, maths, as I said maths is a difficult subject, so if you don't love it, maths won't love you back, so when I knew that I practised and the results that I get are satisfying, I will encourage, that will boost my confidence and say but you can do better because you managed to get these results whereas you worked hard for them so if you put if you keep on working harder you get more, you get more satisfactory results.' (Mandla*)

'Uh, I tend to reflect and see my mistakes take a minute to step back and reflect on what I did well and what I did right and to see if the study plan that I have uh used, is it working for me or is it not working because it would be useless to continue to using the same study skills but getting less results so I use that information to be able to see where I can improve and where I can change my study skills.' (Nomsa*)

'I will first look at which one, which one I didn't understand and then after then I will work on it, so that I become perfect.' (Sam*)

'My results like they encourage me like to do more, put more work, yah effort.' (Sipho*)

Self-awareness is crucial for a learner to self-regulate. The learner needs to be able to deploy, in a dynamic manner, specific learning processes to develop mathematical resilience (Zimmerman, 2002). Data from the semi-structured interview reveal that learners rely on a variety of strategies such as their personal attitude and the identification of an entry point in their journey to develop mathematical resilience. Through a positive attitude, mathematically resilient learners can stay focused on the task at hand and start with the easy tasks and progress to what is perceived to be challenging, as indicated in their comments:

'I have a very positive attitude, even though it seems like somewhere somehow, I do doubt myself, but I remember that I do have that potential.' (Vivian*)

'Yah challenges I cope with them in … I would say an unusual way, 'cause every time uh I kinda not achieve what I wanted to achieve in mathematics I always stay positive which is very hard for people to do that.' (Nomsa*)

'Okay, if, if like I have too much work to do like yah, I get to the bottom of it like, I will not sleep, I make sure like everything is done.' (Sipha*)

'Uh, basic, basically, when, when I start revising maths, I always make sure that I drink a lot of water so that my brain will, will function with me, will work with me well with my body, so when, when I start, I start with the easy problems so that I will gain confidence.' (Mandla*)

Mathematically resilient learners can identify an entry point (a topic or chapter in mathematics) in mathematics that is used as leverage to understand other seemingly challenging topics in mathematics. Algebra featured prominently, followed by statistics. Such a stance points to a learning strategy described by Zimmerman and Pons (1986) as seeking and selecting information. In such an instance, learners are exercising control over their personal skills as well as the task at hand. Starting with the easy topic and moving to a challenging one demonstrates confidence and they are more likely to persist doing the task to achieve the desired levels of outcomes (Pintrich, 2003):

'Algebra.' (Mandla*)

'Okay, I will say algebra because like ay, it's the like, okay, maybe I can say is the mother of mathematics, yah.' (Sipho*)

'Paper 1 [*Paper 1 is an algebra paper*] mina ukuyenza kwami ngiyenza izinto engazaziyo, ngisebenza kakhulu entweni engiyi-understanda kakhulu. [*I work mainly with a topic that I understand better*].' (James*)

'The first chapter in mathematics, I fell in love with was stats I think because I passed.' (Busiswe*)

Apart from identifying an entry point to exploit, mathematically resilient learners show persistence (Dweck, 2012). Results from the semi-structured interview reveal that resilient mathematics learners on average spend between half an hour to three hours per day practising mathematics:

> 'I spend about 30 minutes or so because I don't wanna tire up myself and burn out.' (Mandla*)
>
> 'Sometimes boma [*around*] three hours, four hours.' (Sam*)
>
> 'Sometimes two hours, it can go as far as three hours.' (Busisiwe*)
>
> 'In a day Sir, day ngisebenza [*I practise for*] two hours.' (James*)
>
> 'I don't measure my time, like I just, I just practise maths until I feel like yah, I'm enough, like it's enough.' (Sipho*)
>
> 'Okay, uh, firstly, I practise maths for one hour, but now seeing that or I saw that, practising maths for one hour me as an individual, just doesn't do any, any, any, any, uh. it's not benefit able enough for me, but the more I increase the hours, like right now, I'm practising maths for two, uh, two hours and 30 minutes, so it does help me.' (Vivian*)

Apart from spending a considerate amount studying mathematics, mathematically resilient learners in this study have reported that they use textbooks together with study guides loaned to them by the Gauteng Department of Education through their respective schools for the year as well as past examination papers that are freely available on the Gauteng Department of Education website. Provision of learning resources and the use thereof by learners is crucial in facilitating mathematical resilience for individual or collective needs (Ungar et al., 2013):

> 'I tend to use my question papers my answer series that … uh, my answer series and I use my textbook, 'cause I have noticed a trend, you would find things in a textbook, but you wouldn't find them in a question paper and the textbook helps you relate to the question paper, so I use my textbooks and my question papers.' (Nomsa*)
>
> 'I use study guides.' (Sam*)
>
> 'I make sure that, I, okay, I put my textbooks just to refer if I get stuck, just to put them there on, to lay them on the table and then my questions papers as well, then yah, I just practise, practise, practise.' (Vivian*)

Discussion and conclusion

The main purpose of this study was to explore how disadvantaged learners learn mathematics in a disadvantaged environment**.** Analysis of the semi-structured interviews revealed two interrelated themes, namely foreground and growth strategy. Foreground (forward-looking), as conceptualised by Skovsmose (2012), entails the opportunities that the political, economic, and social context makes available to a person and how these opportunities are experienced and interpreted. In other words, the interpretations epitomise the processes that an individual secures for themselves, not only social resources (teachers) but also the physical resources (textbooks, study guides and past exam papers) that they need to develop mathematical resilience in the context of adversity.

Foregrounds are made up of obstructions that may be regarded as learning barriers that have the potential to ruin the learners' foreground (Skovsmose, 2012). Through the semi-structured interviews, learners expressed their proximal risks or challenges, particularly in their respective community environments, that they must overcome in their learning of mathematics. The immediate community environment was depicted as not helpful and not supportive due to noise and ignorance. This is similar to a study conducted by Neshila (2018) in Namibia with mostly learners who were able to develop mathematical resilience despite coming from surroundings that are noisy with outlets such as bars.

According to Skovsmose (2012) foregrounds are made up of possibilities and the subjective interpretation of such possibilities. Similarly, resilience located in a socio-ecological setting assumes many processes that can be taken by an individual that can lead to well-being (Ungar et al., 2013). Despite a noisy and harmful environment, learners in this study explicitly expressed their hopes and aspirations. Data revealed a constellation of motives for doing mathematics. The constellation of motives displayed by learners in this study stands side by side with the findings revealed by a variety of studies such as Kacerja (2011) and Hernandez-Martinez and Williams (2013) when they found two major motives for doing mathematics are the use value (with respect to pursuing a career or vocation that uses mathematics, for instance, mathematics teacher) of mathematics and the exchange value (the need to do mathematics as a prerequisite for a qualification) of mathematics.

Emerging from the semi-structured interview data is the central role that the teacher plays in support of the formation of learners' foreground. Here, teachers are perceived by learners as a source of motivation or inspiration in support of the learners' foreground. Thus, teachers are viewed as showing an interest in the learners' foreground. Showing interest in a learner's foreground requires that the teacher shows an understanding of the issues that confront the learner in a respectful manner (Liebenberg et al., 2016; Sosa & Gomez, 2012). Mathematics teachers are strategically positioned to take up the responsibility of assisting learners to visualise a better future (Skovsmose, 2005, 2012). In other words, teachers play a pivotal role in enabling learners to construct and reconstruct their foregrounds, as foregrounds are not stable but fluid.

Mathematically resilient learners were found to have the ability to interpret their political, economic, and social context, which gave rise to the expression of hope and future aspiration. These expressions of hope and future aspirations mark the connection between the personal and national context (Skovsmose, 2012) as experienced by the learners. Douglas and Strobel (2015) point out that disadvantaged learners in disadvantaged environments need to be aware of the connections between their efforts in mathematics and potential benefits that may accrue from a mathematical career in the future. As expressed by mathematically resilient learners, pursuing a career reveals a pathway to a better future. A closer look at the data from the semi-structured interviews reveals the awareness by these learners of the connections between their efforts and the possibilities of a better livelihood in the future, as revealed by Snyder (2002). By extension, the data reveal the desire of learners to disentangle themselves from their disadvantaged and deleterious environment.

The data from the semi-structured interviews revealed that mathematically resilient learners tend to deploy a variety of learning strategies. In particular, the analysis found that learners use assessment feedback as one of the growth strategies and can identify specific topics that are utilised to develop mathematical resilience. In this instance, such a strategy of using a variety of learning processes is referred to by Zimmerman (2002) as a self-control method wherein the learner evaluates their performance and can adjust their future learning. The use of assessment feedback resonates with Havnes, Smith, Dysthe and Ludvigsen (2012) when they reveal that learners who perform better in mathematics tend to use assessment feedback to monitor their performance to identify sources of challenges. In this regime, learners interpret assessment feedback in accordance with reasonably stable beliefs concerning the subject area, the learning process, as well as the learning product. At the heart of self-evaluation is what Bandura (1995) regards as physiological and emotional states utilised to judge one's capabilities through interpretation of the learning process. Identifying a topic to gain access to mathematics learning and using assessment results as a growth strategy point to the construction of meaning that may be associated with the learner's foreground. Skovsmose (2012) has pointed out that the construction of meaning in learning mathematics is profoundly related to the learners' foreground, as foreground provides conditions for engagement. Thus, the appraisal of one's capabilities and the construction of meaning in many ways shape cognition which ultimately affects behaviours that may indicate and promote mathematical resilience (Ungar, 2015).

Emerging from the analysis of the semi-structured interviews is the finding of the amount of time learners are prepared to spend practising mathematics. This study revealed that mathematically resilient learners tend to spend at least half an hour to two hours per day on average. Learners do not shy away from setting aside a considerable amount of time in learning mathematics. Setting time aside to learn mathematics depicts a commitment or persistence as found by Martin and Marsh (2006). Skovsmose (2012) attributes such an activity to an instrumental approach. In other words, instrumentalism may provide the required commitment and the energy to focus on their mathematics learning.

Understanding foreground requires the acceptance of the complexities of the subjective and external factors at the political, economic, and social level (Skovsmose, 2012). In this study the availability of study materials such as free textbooks and study guides as loaned to the learners by the Department of Education signals the interaction between the political and economic parameters as experienced by learners. In this instance, learners are loaned free study material as well as textbooks as they attend no-fee paying schools. The study found that learners use a combination of resources in their journey of mathematics. After selecting a particular topic, learners in this study indicated that they use mostly textbooks, study guides and past examination papers in preparation for their examination. This result adds to the growing debate about resources in general in the South African educational landscape, with incongruent research findings on the effects of learning resources on learner achievement. On the one hand, a study by Kabi (2016) found that despite strides made by the Department of Basic Education to address inequalities in education, learner mathematics and physical science performance has not improved but has dropped over time. On the other hand, Wilson Fadiji and Reddy (2021), utilising the TIMSS 2015 South African data, showed that the availability of resources had a positive relationship with mathematics achievement.

The concept of foreground in this study shed light on the learners' interpretation of the national and personal context and provided the protective processes that learners leverage to develop mathematical resilience. Attending a no-fee paying school and having free access to mathematics learning material such as textbooks and study guides marks the political aspect of the foreground. The social aspect (hindrances or potential obstructions) was interpreted as unsupportive, noisy and ignorant environments, while the economic interpretation was expressed by learners' aspirations (e.g. study electrical engineering). The use of various learning strategies (identifying a topic to leverage, use of various resources, coupled with the use of assessment feedback) represents the protective processes that mathematically resilient learners engage in to buffer the risk or threat of dropping out of mathematics. Taken together, these different behaviours represent protective processes that mathematically resilient learners engage in to protect themselves against the impact of poverty. Engaging in protective processes is akin to behavioural engagement as viewed through the formative work of Fredricks, Blumenfeld and Paris (2004) that learner engagement may be behavioural, emotional, and cognitive. In this instance, spending time studying mathematics is viewed as behavioural, staying positive in the face of adversity marks the emotional behaviour and using a combination of learning strategies and resources points to the cognitive behaviour of mathematically resilient learners.

A teacher that shows an interest in the learners' foreground is a caring and respectful teacher. Through showing an interest in the learners' lives, teachers can empower (through sharing their personal journeys of life and in mathematics) their learners to develop mathematical resilience. Thus, mathematics teachers are to be encouraged to share their mathematical journeys with their learners and encourage learners to identify a section or topic that can be used as a springboard to navigate mathematical demands.

More importantly, teachers are urged to consider personal urgency of a learner and self-regulated learning strategies to promote mathematical resilience lest we perpetuate the current poor learner mathematics achievement by disadvantaged learners learning mathematics in a disadvantaged environment.

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