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Exploring rural high school learners' experience of mathematics anxiety in academic settings

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The purpose of the study was to explore rural high school learners' experience of mathematics anxiety in academic settings. Mathematics anxiety has been found to have an adverse effect on confidence, motivation and achievement. This quantitative study is exploratory and descriptive in nature. The participants were 403 learners doing mathematics in 18 rural schools in the Free State province of South Africa. Participants completed a 20-item questionnaire and 373 (92.5%) questionnaires were found to contain valid responses and were analysed by a professional statistician at the University of the Free State using the Statistical Package for the Social Sciences (SPSS), Version 17.0. The questionnaire was tested for reliability using the Cronbach alpha coefficient and was found to have a reliability score of .841, indicating an acceptable reliability coefficient. Findings reveal that all learners sometimes, often, or always experience mathematics anxiety in academic settings. It is therefore important for teachers and authorities in education to observe its prevalence and to implement strategies toward the alleviation of the effects of mathematics anxiety.

Keywords: academic settings; achievement; confidence; habitus; learners; mathematics anxiety; rural

Introduction

There exists a crisis in mathematics education in South Africa. Central to economic prosperity is that a numerically literate citizenry be able to engage, manipulate, and understand mathematics as it constitutes an indispensible facet of our daily lives (Adler, Brombacher & Shan, 2000). Disparities in mathematics achievement between urban and rural learners are well documented (e.g. Bassey, Joshua & Asim, 2009). According to Rossnan (2006) mathematics anxiety could develop as a result of the learners' prior negative experiences of learning mathematics in the classroom or at home. Many learners experience, to varying degrees, mathematics anxiety. Chikodzi and Nyota (2010) and Sahin (2008) argue that mathematics anxiety may not necessarily be experienced by learners enrolled for the subject (mathematics) only, since every learner irrespective of the subject enrolled for, makes use of mathematical knowledge in one way or another. Chikodzi and Nyota further contend that the misconception of the non-utility of mathematics in actual life arises from the practice of teaching mathematics divorced from real life, whilst mathematics is deemed to be inseparable from organised life.

City Press (2012) reports that one in six Grade 12 mathematics learners scored less than 10% in the subject Mathematics in 2011. There has also been a massive decline in the number of learners enrolling for mathematics in recent years. For example, 300,000 learners wrote the mathematics paper in 2008, compared to only 225,000 in 2011. Many South Africans involved in education and business view the decline in passes and enrolments in scarce or gateway subjects as a worrying trend. This study was conducted in rural school settings owing to the reality that I face as a teacher-educator attached to a higher education campus that enrols students who not only come from, but also return to teach in, predominantly rural school settings. I am of the opinion that the trend will continue for many years. In addition, this study sought to contribute to rurality and rural education. Historically, rurality and rural education have been marginalised bodies of knowledge in South Africa (Nkambule, Balfour, Pillay & Moletsane, 2011:341). Nkambule et al. (2011) further state that despite several interventions, education in rural areas continues to face a set of challenges owing to, among other factors, the diverse geographic location of the schools, diverse learners' backgrounds and diverse learning styles.

Dieltiens (2008:40) states that "rural schools certainly have problems particular to them; predicaments which require systemic effort and creative ideas" but argues against the assertion that the problem with rural schools is that they fail to provide a relevant education. In order to build a democratic South Africa, rural learners need the same level of autonomy and critical thinking skills as their urban counterparts. In the end, there are rural schools, but not rural education (Dieltiens, 2008). A few analytical frameworks pertinent to the study are discussed next.

Analytical frameworks

Tsanwani (2009) views mathematics anxiety as an irrational and impedimental dread of mathematics. This term is used to describe the panic, helplessness, mental paralysis and disorganisation that arise among some individuals when they are required to solve a problem of a mathematical nature. The literature further indicates that mathematics anxiety refers to a person's feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary and academic settings (Khatoon & Mahmood, 2010; Leppavirta, 2011; Newstead, 1995; 2006; Perry, 2004). It can also be viewed that the sense of discomfort observed while working on mathematical problems, is associated with fear and apprehension to specific mathematics related settings (Khatoon & Mahmood, 2010; Ma, 2003) and seems ubiquitous. The literature shows that learners across all levels (grades) of schooling experience it, in some way or another (Hembree, 1990).

Hadfield and McNeil (1994) proposed a model of mathematics anxiety which revolves around three main factors: *environmental*, *intellectual* and *personality* variables. *Environmental factors* include classroom issues, parental pressure and the perception of mathematics as a rigid set of rules. *Intellectual variables* include a mismatch of learning styles and self-doubt, whilst *personality factors* include a reluctance to ask questions in class and low self-esteem. Chinn (2008) argues that the advantage of this tripartite model is that it considers several, often inter-related factors. However, besides parents, other individuals who either contribute to or are experiencing mathematics anxiety are not clearly stated. A further classification by Baloglu and Kocak (2006) cite three anchors of mathematics anxiety, namely: *dispositional*, *situational*, and *environmental*. In addition to Hadfield and McNeil's elements of the *environmental* variable, Baloglu and Kocak view the elements thereof as issues that affect learners prior to their mathematical engagements; these include age, gender, academic subjects, and previous mathematics experience. The *dispositional* anchor deals with psychological and emotional features such as attitudes towards mathematics, self-concept, and learning styles. The self-concept refers to the learners' perception of their own ability to perform well in mathematics and to learn new topics. The *situational* anchor refers to direct features that result from the mathematics subject which include the design, topics, how the subject is presented, and the availability or lack of feedback.

McAnallen (2010) conceptualised mathematics anxiety as an effective response that includes avoidance of mathematics, subsequent failure to learn mathematics skills, and thus negative career and school-related decisions. Tobias (1978) described mathematics anxiety as "sudden death" for some individuals and later defined it in Tobias and Weissbrod (1980a; 1980b) as: the panic, helplessness, paralysis, and mental disorganisation that arise among some people when they are required to solve a mathematical problem. Ferguson (1986) identified three common types of mathematics anxiety which include: *mathematics test anxiety* (associated with anticipating, taking, and receiving mathematics tests); *numerical anxiety* (associated with number manipulation); and *abstraction anxiety* (associated with abstract mathematical content). Vinson (2001) states that mathematics anxiety should be regarded as something more than a mere dislike for mathematics. Moreover, Mohamed and Tarmizi (2010) are of the opinion that it should be seen from a broader perspective as a complex construct of affective, behavioural, and cognitive accentuations to a perceived threat to self-esteem, which occur as responses to settings involving mathematics.

Mathematics anxiety may also be associated with the social learning theory (Erdoğan, Kesici & Şahin, 2011). Social learning theory focuses on learning that occurs within a social context. It considers that people learn from one another. Negative or positive perceptions of mathematics from parents and/or teachers are likely to give learners some messages (Sahin, 2008). Parents and teachers might emphasise how difficult mathematics is and, at the same time, tell how mathematical skills are essential for learners' future achievements (Thomas & Furner, 1997). Vann (1993) observed that mathematics anxiety in the mother was significantly predictive of mathematics anxiety in children. This implies that mathematics anxiety could be learned behaviour.

Bourdieu's (1992, cited in Brown & Duku, 2008) notion of social practice focuses attention on habituated activities of ordinary living that people acquire through socialisation. Habitus is created through a social, rather than an individual process leading to patterns that are enduring and transferable from one context to another, but which also shifts in relation to specific contexts over time. Habitus is not fixed or permanent and can be changed in unexpected situations or over a long period of time (Navarro, 2006). Bourdieu (1984) views habitus as neither a result of free will, nor determined by structures, but created by a kind of interplay between the two over time; dispositions that are both shaped by past events and structures, and that shape current practices and structures and also, most importantly, that condition our very perceptions. Habitus is conceived as "the mental structures through which (an individual) apprehend (s) the social world…essentially the product of the internalisation of the structures of that world" (Bourdieu, 1986:130). It is an "ensemble of schemata of perception, feeling, evaluating, speaking, and acting that structures all the expressive, verbal, and practical manifestations and utterances of a person" (Cann, 1996:11). This study sought to address the question: *Do rural high school learners experience mathematics anxiety in academic settings?*

Education in rural contexts

The definition of 'rural' still eludes us due to its ambiguous connotations and the obvious and somewhat fallible comparison with 'urban' contexts. According to Sauvageot and da Graca (2007) rurality may be defined in various ways and no universal definition has been adopted. Most rural dwellers work in agriculture, often for meagre rates of compensation. From a learner diversity perspective, public schools in rural areas do not have a good track record in meeting the needs of diverse student populations (Powell, Sobel, Hess & Verdi, 2001). A great deal of diversity among rural students indicates both a challenge to and an opportunity for the state to contribute to closing the many national achievement gaps (DoE, 2005; Ludlow & Brannan, 2010). Most rural areas already face tremendous barriers to high learner attainment and operate in less than favourable policy environments (Johnson & Strange, 2007; Malhoit, 2005).

Mathematics anxiety and academic performance

It is generally accepted that teachers impact learners in many ways. Levine (2008) found that teachers with mathematics anxiety emphasise rule-based strategies and treat mathematics as an arbitrary collection of facts, perhaps to promote an illusion of their expertise and disciplinary power to students. Furthermore, there is often limited classroom interaction, resulting in students' questions not being asked or answered, and knowledge presented as limited and confusing. Frequently, these teaching strategies perpetrate and perpetuate mathematics anxiety in learners. Mathematics anxiety has been found to relate to mathematics performance of learners (Zakaria & Nordin, 2008; Karimi & Venkatesan, 2009). Mathematics anxiety has been found to decrease the efficiency of an individual's working memory because intrusive thoughts and worries take the focus away from the mathematics tasks at hand. This makes it difficult for individuals to think logically and results in increased errors and longer processing times when solving problems mentally. In the long-term, mathematics anxiety leads to decreased competence, reduced completion rates and lower academic performance in the subject (Ho, Senturk, Lam, Zimmer, Hong, Okamoto & Chiu, 2000). Ho et al. (2000) found that learners with higher levels of mathematics anxiety tend to have lower levels of performance in mathematics, suggesting the existence of a negative correlation between mathematics anxiety and performance.

Hembree (1990) concurs that reducing mathematics anxiety is consistent with improving mathematics achievement. Furthermore, Nashon (2006) found that learners, whose mathematics anxiety decreased, experienced an increase in their level of self-efficacy. In addition, learners who experience mathematics anxiety, a subjective discomfort, in academic settings are more likely to delay completion or not do tasks assigned to him/her at all (Owens & Newbegin, 1997). As an irrational fear towards mathematical operations in mathematics classes, mathematics anxiety is found to hinder learners' positive thinking about mathematics learning and feeling calm. This fear causes low self-esteem, disappointment and academic failure (Tobias, 1998; Gresham, 2004; Akin & Kurbanoglu, 2011). Other than achievement, mathematics anxiety has been found to be related to confidence and motivation.

Mathematics anxiety, confidence and motivation

Tapia (2004) and Zakaria and Nordin (2008) reported that learners having little or no mathematics anxiety scored significantly higher in motivation than learners with some or higher anxiety. One of the factors attributable to mathematics anxiety is a lack of confidence, which often leads to decreased motivation. According to Edelmuth (2006), and Kesici and Erdoğan (2004; 2009) learners with mathematics anxiety will often perceive their skills in mathematics as less than those in other subjects and will not enjoy mathematics or will not have the desire to master it. Motivation is another factor that may play a significant role in the experience of mathematics anxiety. Linnenbrink and Pintrich (2002) define motivation as an academic enabler. Pintrich (2004) further stresses the importance of motivational beliefs in the learning process. Learners' effective learning is positively related to their motivational beliefs. According to Atkinson and McClelland's Achievement Theory, individuals possess a disposition towards a tendency to achieve success and avoid non-achievement (Kesici & Erdoğan, 2004; 2010). In some cases, a belief exists in some quarters of society that 'some people can do maths and others can't' (Wilson, 2009a, 2009b).

Research design and methodology

This section focuses on approach, participants, and reliability and validity.

Approach

This primarily exploratory and descriptive study uses a quantitative design to explore rural high school learners' experience of mathematics anxiety in academic settings. An exploratory study is conducted to gain insight into a situation, phenomenon, or community or individuals (Bless & Higson-Smith, 1995; De Vos, Strydom, Fouché & Delport, 2011). The need for such a study could arise out of a lack of understanding of a new area of interest, or in order to be acquainted with a situation (Fouché, 2005). According to Neuman (2011) we use exploratory research when the subject is very new or if we know little or nothing about it. As mentioned earlier, rurality and rural education have been marginalised bodies of knowledge in South Africa; therefore, more research needs to be done and reported on. The overall goal of this study fits well with the general intention of the exploratory aspect as it sought to provide a basis for formulating more precise questions about rural high school learners' experience of mathematics anxiety in academic settings that can be used to conduct further research. A descriptive study provides a picture of the specific details of a situation, a social setting, a relationship (Neuman, 2011) or a picture of a phenomenon as it naturally occurs (Bickman & Rog, 2009). The descriptive nature of this study blends well with its exploratory orientation as it (the study) begins with a well-defined subject/issue (i.e. mathematics anxiety) and sought to illuminate the basic facts and to create a general picture of the learners' experience (De Vos et al., 2011; Neuman, 2011).

Participants

A 20-item questionnaire was distributed to 403 high school learners doing mathematics in 18 rural schools in the Free State province of South Africa. Learners were requested to indicate their experience of mathematics according to the following alternatives: 1 never; 2 sometimes; 3 often; 4 always. It was found that 373 (92.55%) questionnaires contained valid responses. These were analysed by a professional statistician at the University of the Free using the Statistical Package for the Social Sciences (SPSS), Version 17.0. Since this exploratory study did not intend to focus on, among other things, factors such as gender, age, or ethnic differences, such considerations will not be discussed.

Reliability and validity

Reliability and validity are concerns that are approached through careful attention to a study's conceptualisation and the way in which the data are collected, analysed, and interpreted and the way in which findings are presented (Merriam, 2009). Contrary to some perceptions that suggest that issues of reliability and validity are concerned with data gathering instruments only, Merriam suggests that the researcher(s) need to constantly monitor compliance throughout the study. Reliability refers to the degree of consistency of the data gathering instrument in measuring that which it is supposed to measure. Cronbach's alpha coefficient is a measure of internal consistency that shows the degree to which all the items in a test measure the same attribute (Huysamen, 1993; Masitsa, 2008; 2011). Santos (1999:2) adds that the higher the value, the more reliable the instrument. He indicates that 0.7 is an acceptable reliability coefficient. In this study, the Cronbach alpha was calculated for the 20-item questionnaire and found to be .841.

Since the Cronbach alpha coefficient average for rural high school learners' experience of mathematics anxiety in academic settings was .841, and that .7 is deemed as an acceptable reliability coefficient, the coefficient for this study suggests that the data gathering instrument was reliable. To observe content validity, the questionnaire was adopted and structured so that the questions posed were clearly articulated and directed. All statements were formulated in the positive to alleviate the possibility of misinterpretations. It was pre-tested on 34 rural high school learners who belonged to a group that was excluded from the participants in the study and, thereafter, amendments were made to ensure the simplicity and clarity of some questions, making it fully understandable to the participants (Masitsa, 2008; 2011). Furthermore, the researcher was present when the questionnaire was administered and could respond to any uncertainties the respondents may have had.

Results

The study investigated rural high school learners' experience of mathematics anxiety in academic settings. An analysis of these results is presented in Table 1. The mean scores represented the following alternatives: 1 never; 2 sometimes; 3 often; and 4 always.

Table 1 Rural high school learners' experience of mathematics anxiety in academic settings

Statements	*N*	Mean	*SD*	Range
Knowing that the next period will be a mathematics period	372	2.72	1.151	3
Being asked to do mental arithmetic during class	360	2.18	0.954	3
Having to take a written mathematics test	352	2.53	1.140	3
Doing word problems	363	2.09	1.007	3
Doing long division questions without a calculator	370	2.11	1.043	3
Doing long division with a calculator	359	2.53	1.176	3
Doing long multiplication questions without a calculator	365	2.10	1.030	3
Doing fraction questions	364	2.62	1.060	3
Revision for a mathematics test that is going to be given the next day	370	2.70	1.169	3
Doing mathematics assignments	373	3.01	1.175	3
Looking at the marks you got for assignments	368	2.82	1.210	3
Opening a mathematics book and looking at the base of questions you have to	377	2.68	1.149	3
Having to work out answers to mathematics questions quickly	367	2.40	0.975	3
Trying to learn the times table's facts	362	2.47	1.109	3
Waiting to hear your score in a mathematics test	369	2.73	1.194	3
Showing your mathematics tests scores to your parents/next-of-kin	372	2.55	1.168	3
Answering questions the teacher asks you during classes	372	2.62	1.074	3
Working out money when you go shopping	368	2.54	1.208	3
Following your teacher's explanation of a new mathematics topic	372	2.79	1.123	3
Writing a mathematics examination	373	3.21	1.048	3

In Table 1, means ranging from 2.09 to 2.47 indicate that rural high school learners sometimes experience mathematics anxiety in academic settings, whilst means ranging from 2.53 to 2.79 indicate that they often experience mathematics anxiety and means ranging from 2.82 to 3.21 indicate that they always experience mathematics anxiety. There are no means (1.99 and below) indicating that the participants never experience mathematics anxiety in academic settings. The spread of the means indicates that all the learners sometimes, often, and/or always experience mathematics anxiety in academic settings. They always experience anxiety when writing mathematics examinations, doing mathematics assignments and when looking at the marks they received for a mathematics assignment.

Results further indicate that learners often experience mathematics anxiety when: following their teacher's explanation of a new mathematics topic; answering questions teachers ask during classes; waiting to hear their score on a mathematics test; and doing mathematical activities such as fractions. The use of a calculator shows an interesting dynamic. Participants indicated that they sometimes experience mathematics anxiety (mean 2.11) when they do long division questions without using a calculator; when doing long multiplication questions without a calculator (mean 2.10); and often experience mathematics anxiety when doing long division with a calculator (mean 2.53). This means that the use of calculators evokes more anxiety. This seems to support the work of Zakaria and Nordin (2008) who cautioned that mathematics anxiety does not appear to have a single cause, but is a result of a plethora of factors such as truancy, poor self-image, poor coping skills, teacher attitude and an emphasis on learning mathematics through drill (without understanding).

Discussion

Results gleaned from the questionnaire and presented above will now be discussed. Mathematical anxiety affects all aspects of teaching and learning (Mohamed & Tarmizi, 2010). That observation is consistent with the results of this study where no participants indicated that they never experience mathematics anxiety in academic settings. Swanson (2006) concurs that feelings of anxiety do come into play in academic settings. Martinez (1987, cited in Piercey, 2011) asserts that anxiety may be a greater block to learning in mathematics than any supposed deficiencies in our school curricula. Through repeated exposure to recurring stimuli and to common structures, certain behavioural strategies and psychological orientations are rehearsed, modified and eventually embodied, becoming part of the habitus (see *analytical frameworks*). Unfortunately, this is likely to be radiated out to those in close proximity. The social environment offers certain stimuli while withholding others; it recognises certain behaviours but not others; it demonstrates how certain aspirations are both appropriate and attainable; how others lead to frustration and disappointment; and it confers taste and an environment-specific common-sense (Cann, 1996). This is consistent with the social learning theory. According to Orcutt and Schwabe (2012) social learning variables such as the conduct of the teacher, utterances by parents and significant others, and a lack of role models can encourage or discourage learners' like or dislike of mathematics. Learners' experience of mathematics anxiety suggests that their irrational fear of mathematics is likely to lead to behaviour problems (Furner & Duffy, 2002). Mancil and Maynard (2007) maintain that such learners usually engage in behaviour problems to escape mathematics lessons and work.

Conclusion

The purpose of this study was to explore rural high school learners' experience of mathematics anxiety in academic settings. The study revealed that, overall, rural high school learners sometimes, often and always experience mathematics anxiety. This implies that teachers do not only need to be aware of the prevalence of mathematics anxiety among learners, but also its effects on learners' achievement and motivation. Teachers need to help learners realise that mathematics is a ubiquitous and indispensible facet of human existence. Furner and Berman (2003) posit that learners need to view mathematics as a human endeavour so that they learn to value and realise the application for learning mathematics both inside and outside the classroom. Making such connections may help learners realise that it is not something from which they can escape. The next section presents recommendations derived from the findings of the study and the relevant literature.

Recommendations

The current study found that rural high school learners generally experience mathematics anxiety. Research suggests that if anxiety levels are decreased, there will be improvements in cognitive, behavioural and attitudinal aspects of mathematics learning by, for example, manipulating teaching variables such as teacher behaviours, task structure, and classroom atmosphere (Perry, 2004; Jain & Dawson, 2009; Cavanach & Sparrow, 2011). It is generally accepted that preventive or proactive measures lessen damage or effect; therefore, it is vital that the teacher be made aware of factors that may lead to mathematics anxiety. Baloglu and Kocak (2006) and Cavanach and Sparrow (2011) assert that these factors can be classified as attributes of the learner, the family, the teacher and teaching, and the nature of mathematics. This implies a holistic approach to mathematics anxiety.

Rossnan (2006) suggests that academic settings that seek to reduce mathematics anxiety should strive to create space that encourages each individual's strengths and successes. Teaching and learning in mathematics should address a variety of learning styles. The theory of multiple intelligences advocates the notion that all learners can learn, but in different ways.

Mancil and Maynard (2007) suggest the modification of four aspects; firstly, to modify mathematics content. This can be accompanied by altering the type or amount of content presented to the learner. For example, the teacher may give five mathematical problems at a time rather than 50 problems at once. Secondly, modify teacher behaviour. To reiterate, Levine (2008) found that teachers with mathematics anxiety emphasise rule-based strategies and treat mathematics as an arbitrary collection of facts, perhaps to promote an illusion of their expertise and disciplinary power to students. In modifying teacher behaviour, teachers can verbally restate directions, write them on the board and provide learners with a task card to aid in completing assignments. Thirdly, task demands can be modified. This can be accomplished by allowing learners to respond to questions in different ways. For example, allowing the learner to respond by pointing rather than giving oral responses or oral rather than written responses. Lastly, modifying the mode content delivery can be done by changing the teaching agents, teaching format, and teaching context. Learners may be exposed to computer-assisted instruction, for example.

A six-day workshop for mathematics teachers in rural districts of New Mexico, designed around manipulatives (concrete objects used to teach a concept), was found to yield a statistically significant reduction in mathematics anxiety among the participants (Piercey, 2011). So, the study recommends an engagement of such a nature for South African Mathematics teachers in rural contexts. Levine (2008) recommends the existence of clear and well-articulated academic expectations. Participation by learners in an academic endeavour with unclear or unarticulated norms may appear overwhelming to the learner and resultantly increase experiences of mathematics anxiety. Constructivist theory maintains that learners, in the construction of knowledge, become active participants. Learners therefore need to be actively involved and mathematics should be made relevant to their everyday lives. Furthermore, teachers need to create inviting academic settings that will help learners feel more successful, that they can do better, despite failures. Such academic settings are more likely to reduce mathematics anxiety, encourage learner participation, and enhance motivation, confidence and improved academic performance.

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