

PLAGIARISM DECLARATION

PLAGIARISM

This means that you present substantial portions or elements of another's work, ideas or data as your own, even if the original author is cited occasionally. A signed photocopy or other copy of the Declaration below must accompany every piece of work that you hand in.

DECLARATION

1. I know that Plagiarism is wrong. Plagiarism is to use another's work and pretend that it is one's own.
2. I have used the American Psychological Association formatting for citation and referencing. Each significant contribution to, and quotation in, this essay/report/project from the work or works, of other people has been attributed, cited and referenced.
3. This essay/report/project is my own work.
4. I have not allowed and will not allow anyone to copy my work with the intention of passing it off as his or her own work.

NAME: Layla Omar

SIGNATURE:



STUDENT NUMBER: OMRLAY001

Stereotype Threat, Gender, and Mathematics Performance in Four Western Cape Schools

Layla Omar

ACSENT Laboratory

Department of Psychology

University of Cape Town

Supervisor: Katherine Morse

Co-Supervisor: Colin Tredoux

Abstract: 246

Body: 10000

Abstract

Females and students of colour have been found to perform poorly in mathematics. Research has found that females underperform in mathematics due to the stereotype that men are better than women at mathematics. Females are more likely to report anxiety during mathematics assessments, one reason could be because they want to disprove the stereotype, but then underperform due to the excess stress. Similarly, students of colour underperform due to the stereotype that they are intellectually inferior to White people. Studies have found that physical student-teacher congruence could mitigate the effects of stereotype threat (ST) and improve mathematics performance of women and students of colour. Discussion groups ($n = 64$) examined whether Grade 9 students in four Western Cape (South Africa) schools were affected by ST about mathematics performance, and whether they perceived student-teacher congruence could be helpful in mitigating this. In our sample, race-based stereotypes were not prominent, but students were aware of gender-based mathematics stereotypes. Students did not see value in physical student-teacher congruence and instead spoke about the qualities of a teacher that could improve their learning. Study 2 ($n = 198$) used linear mixed-effects modelling to determine the extent to which ST was present and whether the perceived quality of the teacher-student relationship mitigated ST. We did not detect effects of ST on young women, and the perceived teacher-student relationship did not influence mathematics performance. ST does not seem to be a significant impediment to mathematics performance in the four schools we surveyed.

Keywords: stereotype threat; math; achievement; student-teacher congruence; gender; teacher-student relationship

Why does mathematics (maths) come as a dream to some and a nightmare to others? Many high schoolers across the globe struggle with maths and perform poorly on assessments (Foley et al., 2017). This is concerning as high school maths opens doors for many further studies and careers. Determining why students struggle with maths is a pertinent issue to improving maths performance. If it is known that some students struggle with maths because of their teacher's inability to explain concepts well, interventions can be targeted at teachers. Similarly, characteristics of individuals that may explain poor maths performance are worth exploring.

Despite generalised difficulties in maths, research has found that poor maths performance is inflated along racial and gender lines; amongst students of colour and females (Chukhray & Shifrer, 2015). Both students of colour and females belong to race and gender groups that have negative maths stereotypes associated with them. *Stereotype threat* (ST) theory explains how students from a particular race or gender group often fall prey to a negative stereotype about their ability. During maths tests students of colour and females typically experience more stress than students who do not fall into race or gender categories that have negative maths stereotypes associated with them. The extra stress arises predominantly from pressure to disprove the stereotype. Due to these recurring stressful thoughts, space in their working memory is diminished which mediates poorer performance on maths tests, perpetuating the stereotypes (Bedyńska, Krejtz, & Sedek, 2019). Thus, finding ways to mitigate ST could be beneficial for affected students who are performing poorly at maths.

Teachers have an influential presence in students' learning environments (Lai, 2015). Since ST occurs on a group basis, solutions based on group membership present as a logical solution. Thus, exploring the similarities between students and teachers could provide insight into students' maths performance. *Student-teacher congruence* refers to teachers and students with the same race or gender. Increasingly, research is looking at effects of student-teacher congruence on student outcomes (Fox, 2016). If students who experience ST about maths have competent maths teachers with matching race or gender, those teachers can serve as role models, disproving the stereotype (Lai, 201). Teachers' perceptions of their students are more positive and teacher-student closeness is better when there is student-teacher congruence of race or gender (Saft, & Pianta, 2001; Yiu, 2013). Consequently, a possible mitigator of ST is student-teacher congruence. The current research looked at the prevalence of ST and investigated whether student-teacher congruence could act as a mitigator, thereby improving maths performance.

Stereotype Threat

Steele (1997), an expert in the field, frames the ST problem well in the United States: students can attend the same school, have the same teachers and textbooks, yet can experience a classroom significantly differently, thus affecting their achievement. ST may influence intellectual functioning through producing anxiety in the members affected as they fear confirming a stereotype. A further concern is that awareness of stereotypes lasts longer than their perceived validity. The stereotype that women perform worse than men at maths is still prevalent, despite it being disproven (Hyde, Lindberg, Linn, Ellis, & Williams, 2008). Thus, even when stereotypes are known to be false, people can still be affected by ST.

There are immediate and future implications for women affected by ST, their self-confidence decreases, which creates avoidance to study higher level maths (Kapitanoff & Pandey, 2017). For two provinces in South Africa (SA), Gauteng and Limpopo, data shows that girls are 8% and 5%, respectively, less likely to take maths in Grades 10-12 compared to boys (van der Berg, van Wyk, Selkirk, & Rich, 2019). As fewer women take higher level maths courses, male dominance in maths-related careers is reinforced and preserved.

In the past, White men have dominated higher education fields of science, technology, engineering and mathematics (STEM) (McGee, 2018). Stereotypes arose from scientific racism that postulated Afro-American academic inferiority. In SA differences in socioeconomic status (SES) generally fall along racial lines, stemming from apartheid (Graven, 2013). It is suggested that these differences cause major performance gaps amongst learners, including in maths. In the poorest quintile of South African schools, only 22% of students obtain maths results above 40% (Cronje & Matwasa, 2018). A deficit discourse in SA propagates helplessness and beliefs that those with lower SES, mainly people of colour, will be unable to succeed in education (Graven, 2013). This causes learners from lower SES to underperform academically and creates further disempowerment for them.

Apart from students' knowledge of stereotypes affecting them directly, the attitudes of their teachers too impact their performance - South African teachers view boys as being significantly better than girls in maths (Mwamwenda, 2011). When stereotypes are held by teachers it often leads to differential treatment of students in the classroom (Li, 1999). This differential treatment impacts students' beliefs about themselves and ST effects follow. Even if teachers do not hold stereotypes, students themselves may believe that teachers do. This may impair their maths performance, perhaps as they perceive teachers to have lower expectations of them than of others.

Mitigating Stereotype Threat

There is potential for teachers to break the ST process in the ways they relate to students in class. Teachers can influence students' perceptions about their own maths abilities. "Students can leave the classroom with their knowledge and attitudes dramatically altered from what they were before they entered" (Wenglinsky, 2002, p. 2). Certain characteristics of teachers, possibly student-teacher congruence, could have meaningful impacts in mitigating ST. Although research on student-teacher congruence is limited, initial studies from diverse samples have found favourable results.

A Californian study examined whether students of colour benefited by learning from instructors of the same race (Fairlie, Hoffmann, & Oreopoulos, 2014). The researchers examined demographic characteristics in the form of administrative data, including the race of students and lecturers from 2002-2007. Findings were positive for students of colour who shared the same race as their lecturers, as student grades increased significantly. There were fewer dropouts and the likelihood of students of colour obtaining a grade B or above increased significantly from base rates by up to 3.2 percentage points. These findings are promising as fewer dropouts means there is a higher likelihood of students of colour having access to maths-related careers. Furthermore, if more students of colour follow maths-related careers they could serve as role models for students experiencing ST about maths.

A large-scale longitudinal study in Tennessee looked at student-teacher race congruence for grades three through eight in relation to reading and maths performance (Joshi, Doan, & Springer, 2018). They found that there was no significant effect on reading in elementary or middle schools. Results from fixed effects modelling of maths performance in elementary school samples showed that congruence between White students and teachers were not significant. However, racial matching for Afro-American students significantly increased maths performance by $.08$ *SDs*.

A South Korean study of middle school students that looked only at gender congruence between students and teachers found further supporting results (Lim & Meer, 2017). The performance of female students with female teachers significantly increased in maths courses. The effect of female students being paired with female teachers was greater than when male students were paired with male teachers. This makes sense as gender stereotypes do not make boys think that they are less adept at maths than girls.

A study using a quasi-experimental design examined the gender achievement gaps in Chinese middle school students (Xu & Li, 2018). Like previous studies, maths results improved significantly for female students of female teachers, by $.15$ *SDs*. A unique feature of this study was that students' beliefs about their abilities in certain subjects were explored

through subjective measures. Thus, the study went beyond only examining objective academic outcomes.

Despite promising research on student-teacher congruence around the world, no South African studies were found. Education systems during apartheid were the producers of educational disparities in content, school funding and resources in schools for students of colour around SA (Nkabinde, 2016). Although there is continuing emphasis on diminishing past inequities, there is still much hardship for students of colour in SA, particularly for Black Africans in township schools (Nkabinde, 2016). Thus, the basic schooling of Black Africans in townships has led many to failure in matric exams particularly in maths and science (O'Brien, 2010). The research shows there is a need for a solution to improve the maths performance of students of colour. As teachers in SA are faced with challenges in planning and implementing effective quality education for students, it seems wise to explore student-teacher congruence in SA.

Conclusion

This review explored the validity of student-teacher congruence mitigating ST and improving maths performance. The existence of gender or race-based maths stereotypes could lead to ST, despite their dubious veracity. The studies had correlational, quasi-experimental and longitudinal designs and focused on samples diverse in age and location. The methods used were mainly quantitative which gave significant statistical results but lacked qualitative insight. Overall the findings supported the idea that student-teacher congruence could reduce ST. The strongest finding was from the pairing of female students with female teachers. There was also significant maths improvement for students of colour paired with same-race teachers. Student-teacher congruence is a logical solution to mitigate ST and evidence supports it, but no research has looked at students' beliefs towards student-teacher congruence. The current research investigated whether ST affected students' maths performance. Mixed methods were used to add depth to understanding ST and the role that student-teacher congruence has on it.

Study 1: Rationale, Specific Aims, and Hypotheses

Maths achievement in South African schools is extremely poor (Spaull & Kotze, 2015), researchers have tried to model achievement. Findings show that teacher competency, English proficiency, and school resources significantly affect maths achievement (Howie, 2003). However, research in SA has not focused on psychological predictors. Due to prevailing effects of apartheid, students of colour predominantly attend schools with poor

quality education (Spaull, 2013). Additionally, gender distributions in STEM fields remain in favour of males. Because racial and gender issues remain prevalent in SA there is a possibility that ST contributes to poor maths achievement in addition to physical determinants. For the literature reviewed in which ST was identified, student-teacher congruence was found to successfully mitigate its effects. Therefore, it was important to investigate whether maths stereotypes existed in Western Cape (SA) high schools and see whether high school students perceived that student-teacher congruence (a solution in other countries) could mitigate ST, thereby improving performance. Qualitative methods were used in study 1 to determine the maths stereotype most prevalent in the Western Cape, based on race, gender or background (community).

Aims of study 1:

1. Explore whether maths stereotypes affect high school maths students,
2. Examine students' views on student-teacher congruence, in terms of potential benefits to learning maths.

Hypotheses for study 1:

1. Girls would be more susceptible to ST than boys, due to the stereotype that men are more skilled in maths than women,
2. Students of colour would be more at risk of ST than White students, due to the stereotype that people of colour are intellectually inferior to White people, particularly in STEM,
3. Female students would prefer having same-gender maths teachers,
4. Students of colour would prefer same-race teachers.

Study 1: Methods

Design and Setting

This was an exploratory qualitative study to determine whether ST affected students and what their beliefs were surrounding student-teacher congruence. The data collection took place in four Western Cape high schools. This was part of a larger study where the participating schools were previously selected. Table 1 shows that schools were chosen to include variation in school fees and past bachelor's pass rates. The selected schools suited the research aims as they were racially diverse. Since race-related stereotypes about maths were investigated, it was important that the sample had racial variation presumably with different perspectives. The variation in bachelor's pass rates may have suggested differences within the schools, such as different teaching practices, which was necessary to explore in this research.

Table 1
Profiles of participant schools

| School | Fees per year | Bachelor's pass |
|----------|---------------|-----------------|
| School 1 | R0 | 47% |
| School 2 | R4000 | 38% |
| School 3 | R8000 | 88% |
| School 4 | R30000 | 84% |

Note. Fees per year are approximate values.

Bachelor's pass information available in public domain via:
<https://matricresults.news24.com/2018/province/wc/school>

Participants

Recruitment. My supervisor, Katherine, and I recruited participants from the four schools specified using stratified sampling. We considered those who were in the top and bottom 30% with regards to their 2018 Grade 8 term 4 maths marks. We chose from the extremes because having a wide range was better for exploring predictors and explanatory variables. Since I was interested in perceptions of race and gender competence in maths, I tried to include racial and gender variability when selecting participants. Overall, we had $n = 64$ students in study 1 (16 students at each of the four schools). Students at each school were grouped according to high and low maths achievers. Thus, each discussion group at the schools consisted of $n = 8$ students. Teachers were informed of the selected students and they arranged a school venue for the discussions.

Eligibility criteria. Only Grade 9 maths students in the four chosen schools could take part in the study. Students had to be in Grade 9 for us to determine whether they were high or low maths achievers since we needed access to a previous high school mark (Grade 8 final mark). From Grade 10 onwards students would have chosen to study maths or maths literacy, consequently those who chose maths may have had relatively homogenous viewpoints.

Measures and Materials

The discussion groups were semi-structured. We predetermined some structured questions but allowed for deviation from these depending on what participants offered in the discussions.

Structured questions. Katherine and I created questions (Appendix A). My primary questions were about students' awareness of maths stereotypes in their social environments. If appropriate, I followed up with questions about their endorsement of the stereotypes and

whether it affected them. I asked for students' perceptions on potential benefits of student-teacher congruence. Other questions were relevant to Katherine's aims.

Comment cards. Questions asked had two corresponding cards with opposing hypothetical responses to the questions on them. These helped start discussions as students could agree or disagree with them and elaborate (Appendix A).

Audio recorder. The Zoom Handy H2 recorder was used to record the discussions.

Data Collection Procedure

We met with each discussion group twice, two weeks apart. The discussions were in English, since all participating schools were English-medium. In school 1 we noticed that the low achievers hardly spoke, which we thought was due to English not being their first language. Therefore, a community worker attended the second discussion to translate for them, however they still said very little.

Once participants arrived for the first discussion, we introduced ourselves and reminded them of the research goals and ethical considerations. Students received comment cards. Before either researcher posed a question to the group, students read the corresponding comment cards out loud. Then the question was answered, and the process repeated. These discussions lasted approximately 45 minutes.

The second discussions were short, lasting approximately 15 minutes. Participants were asked to elaborate on their thoughts from the previous discussion to provide clarity, new insights and depth to the data. They were debriefed at the end of this session.

Data Analysis

I used an interpretive approach to describe and make sense of students' beliefs. After the discussions were transcribed, I performed a thematic analysis following the steps outlined by Braun and Clarke (2006). I analysed the full transcriptions and coded the sections that were relevant to my research questions. Thereafter I generated themes and revised them until labels were generated that encompassed the themes fully. My supervisor, Katherine, also performed a thematic analysis on the data separately and we compared our findings to check that our themes aligned (Smith & McGannon, 2018).

Ethical Considerations

Consent and Confidentiality

Ethical approval was granted by the University of Cape Town Department of Psychology's Ethics Committee for studies 1 and 2, reference number PSY2018-066 (Appendix B). Consent was obtained from the Western Cape Education department (Appendix C), principals of participating schools (Appendix D), parents of students and

students themselves (Appendix E). We informed participants that participation was voluntary, and they could withdraw their contribution without consequence at any point during the data collection or during the write up. We assured them that the data would remain confidential. No student or school names were used from the discussion groups, only gender and race of the student was recorded.

Risks and Benefits

There were no major risks to taking part in the studies. However, students who found maths stressful may have felt slightly stressed during the discussions. They were not forced to share more information than they were comfortable with.

There were small benefits to taking part in the research. Students got to experience taking part in research which likely excited them. They obtained knowledge from first-hand researchers by asking questions about how research worked. The data they provided may not have directly benefited them but enlightened future research and practice.

Debriefing

At the end of discussions, we provided summaries of the points raised in the discussion to allow for possible clarifications. We answered any questions they had and made sure students were not distressed when leaving the discussions.

Reflexivity

Reflexivity is a crucial aspect of qualitative research, where researchers undergo critical self-evaluation of their positionality and reflect on how they may have influenced data collection or interpretations (Berger, 2015). I introduced myself to participants as a student who completed a BSc, majoring in maths and psychology at the University of Cape Town and said the research would go towards completion of my psychology honours project. Given that participants knew I was highly competent at maths, and many of the participants might have felt they could not understand maths well, me asking them questions about something they struggled with may have made them less likely to divulge material. Although I could not control this, I consciously tried to convey a neutral stance of “I value maths, but it’s ok if you do not” in my body language and phrasing of questions and comments. I think being a non-White female would have promoted participants to share their views as my race and gender had negative maths stereotypes associated with it that was a central topic of interest. Katherine introduced herself as a PhD student and explained that she went back to university when her son started his first year. Given that some questions asked about parental expectations linked to maths, participants may have been reluctant to give honest accounts due to Katherine being a parent. Since Katherine spoke with an Australian accent,

participants may have been more unwilling to share their experiences if they felt they would be judged by a foreigner.

Study 1: Results and Discussion

During discussions with the participants two relevant themes emerged from the eight groups. Firstly, maths intelligence, in which students spoke about their awareness and belief of stereotypes, and their reactions to them. Secondly, teacher themes, in which students shared their perceptions of student-teacher congruence, spoke of effective teacher communication and admired teacher qualities. Although there was slight variation in the presentation of themes across the four schools, the essence relating to the research questions was consistent. For instance, although discussion groups were aware of some different stereotypes, a lack of belief in stereotypes was consistent, similarly for the teacher congruence themes. I expanded on the themes below and provided extracts from the discussions as supporting evidence. In the extracts, “L” indicates a learner speaking, “Ls” indicates multiple learners, “K” and “La” denote the researchers, Katherine and Layla, respectively.

Maths Intelligence Themes

Awareness and belief of stereotypes. Most students were aware of the stereotype that boys are better than girls at maths, however none believed it as they said there were no gender differences relating to maths ability. Awareness of the gender-based stereotype was consistent with other research, as well as stereotypes being prevalent in social environments that students interacted with. Research has shown that stigma consciousness, (thinking others believe a stereotype associated with them) can lead to ST (Picho & Brown, 2011).

L (Coloured female): What I think is that everybody is equal, and everybody has potential to do well so that's what they try for all the kids, but I do see some stereotypes like um it does say stereotypes?

La: Yes, yes it does

L: Like boys would be smarter than females and girls, I've heard that a lot.

K: Where do you hear that? Where do you hear that idea? Who is saying that?

L: I just hear it in like the environment around me sometimes. It's like they... they just generally think that boys are smarter than girls...

Contrary to negative female maths stereotypes that were expected, some had heard of stereotypes that promoted girls, saying girls were better than boys academically, including at

maths because they were more organised and paid more attention in class. They partially believed this but emphasised that it was not appropriate to generalise. These responses were tangential to the aim of the question. That is, students suggested roles of mediating factors like girls being organised and paying attention rather than gender stereotypes specific to variation in maths ability.

L (Coloured male): Mam don't get me wrong here, people are all like the same things mam but they say that girls are more like organised mam, so like they do things better, they know what is and what and how to put it all, and sometimes boys are like all over the place mam, but it's not all boys and it's not all girls that are so mam.

K: Why do you think the girls were all the top achievers?

L (Coloured female): Because they pay attention more in class where boys will talk with each other and not concentrate on the teacher.

A notion of equality surfaced, indicating that gender and racial differences do not determine maths ability, it is how individuals manage the opportunity of learning maths. We think that extracts such as the one below are counter-narratives to apartheid. As children grew up in South Africa, they inevitably learnt about apartheid that was founded on racial differences, as its effects are still seen today. Post-apartheid school textbooks have been used as a tool to rectify racial stereotypes of the past (Engelbrecht, 2008). Emphasis in schools was placed on students learning that people have the same capabilities, regardless of race. We therefore think it has been instilled in students of colour that they are not inferior and that they can perform well academically if they put in the effort. This could explain why students were not aware of the stereotype that White people are intellectually superior to students of colour, as they have grown up in a society where most emphasise racial equality to rebuke apartheid.

L (Coloured male): I think that everybody's equal mam, you can be a girl or a boy, your skin colour doesn't matter, it's what you make of the opportunity.

Although there appears to be a mixture of views on the awareness of gender-based stereotypes, where most had heard of the stereotype that boys are better than girls at maths, some argued that girls were better than boys. However, stating girls were better academically

was substantiated by stereotypical differences in work ethic, rather than perceived innate gender differences. There was also the notion that all genders are equal and belief that differences in performance were due to effort, not the gender of the student. Participants did not offer racial stereotypes, likely due to the counter-narrative of apartheid. Few participants said they thought others believed students were less likely to succeed if they came from a poor background. The effect of the gender stereotype was focussed on in study 2 as it was the most prevalent stereotype in the sample.

Reactions to stereotypes. Girls who were aware of the stereotype that boys are better than girls at maths, felt it did not negatively affect them. ST theory says that girls experience extra stress due to the stereotype, which leads to underperformance. However, most girls in the sample said it had spurred them on and was a helpful push to succeed. These reactions from girls were unusual as many studies found that ST made maths-related experiences less enjoyable and more difficult.

K: ...we've talked about the idea that ... um... you don't believe that boys are smarter than girls, but other people might believe that. Does that cause pressure for girls to have to work harder to prove that they are smart?

Ls: Yes

K: You think it does?

L (Coloured female): We try to prove a point.

K: Ok, and is that helpful pressure or does it make it hard to achieve because it's extra stress?

L: It's helpful

There was one female student in the sample who felt that the stereotype was not helpful and put unnecessary pressure on girls, which she did not like. She seemed to be expressing the idea that all individuals are capable of achieving different things and comparisons are unhelpful if you tried your best. She suggested one should work hard to do the best they could for themselves, not in order to disprove a stereotype or prove someone wrong. Considering that it was odd that she was the only girl to find the stereotype threatening, one could interpret her stance below as one that opposes comparisons in general, rather than specifically being distressed by the stereotype. However, she may well represent a minority of girls' opinions of the stereotype causing more pressure, which coincides with what theory led us to expect.

L (Coloured female): I feel like it's not good because it adds extra pressure and you are where you are and you can try your best, and that's you trying your best, and you don't have to prove a point to show someone that you're worthy of having a title, that you're smarter than boys coz if you're smart, you know you're smart. It's ok if you know that.

Participants spoke of some positive maths stereotypes based on appearance and culture. A girl said that she knew others believed that people who wore spectacles were smart, but she wore spectacles and said she was not good at maths, so disregarded the stereotype. Similarly, a boy said there was a stereotypical “nerdy” look that resulted in people thinking someone with that appearance must be smart, but he dismissed its validity. Most students knew of “smart Asians”, but said those students likely achieved highly because of parental discipline practices. Participants had heard people say that Muslims and Indians were smart at maths, but they provided counter-examples as proof that it was not always true. The discussion of positive stereotypes captures the sample’s stance of not believing stereotypes. Participants were critical of stereotypes and provided “evidence” from their lives that disproved the stereotypes. Even when stereotypes favoured their own demographic group, they did not naively believe them.

The finding that girls claimed not to be affected by ST, opposed my hypothesis. However, I was not convinced that their claims were true. Research showed that girls could be negatively affected by ST even if they did not believe the stereotype (Huguet & Régner, 2009). Thus, I thought that ST may impinge their performance without them realising it had. I therefore believed a quantitative approach to test this hypothesis would be more conclusive. The hypothesis that students of colour would be more susceptible to ST was not supported as participants were unaware of race-based stereotypes, and awareness is necessary for ST.

Teacher Themes

Student-teacher congruence. Since the most prominent gender-based stereotype was that boys are better than girls at maths, it was expected that female students would prefer having female teachers. Research suggested that female students would be able to relate better to female teachers, who could act as role models disproving the stereotype. However, across all discussion groups, girls did not feel that having a female teacher would benefit them or improve their maths performance. Boys also did not prefer matching teacher gender.

L (Coloured female): ...as long as the teacher is good at their job and I'm going to get high marks, I don't really care if it's male or female...

L (White male): It doesn't matter what the person looks like or gender or anything it's about if you take what they're teaching in and if the teacher is teaching the maths as well.

Some students reported having physically congruent teachers for the year and incongruent teachers previously. They preferred the incongruent teachers as they taught well, whereas the physically congruent teachers taught poorly. They used their experience to show that the physical features of the teacher were not important, it was the competence of the teacher that had the biggest impact.

L (Black African female): Last year we had different kinds of maths teachers and they all taught well, but this particular teacher this year...

All other students agreed that physical congruence in terms of gender, race or background was not an important predictor in determining their maths performance. They believed that effective teaching was key to their success and being a good teacher did not necessarily equate to physical student-teacher congruence.

L (Coloured female): It doesn't matter if you are a different race or background or anything like that, I just think that a good teacher will bring the work across in an easy way of understanding, that will be great for the whole class.

Teacher communication. Many students spoke about how they preferred when teachers spoke at an easy level of understanding and did not use unnecessarily complicated words. They felt that a teacher talking on a level that one would with a friend, made it easier to relate to. Below are two extracts that illustrate this.

L (Coloured female): I prefer when my teacher speaks to me the way my friends speak to me like, don't, don't talk to me in that high English advanced, I want the way my friends speak to me coz then I can understand it and I can relate to it

L (Coloured female): Um my favourite teacher being Ms J, she teaches, she taught us EMS last year and she teaches in a way that we understand coz she talks how we talk like she doesn't use big words and things so she would explain it like in a way that we will take it in...

If complicated words were needed to be known in the subject, then students appreciated when teachers explained them carefully or broke down the complicated words into smaller words rather than assuming students understood the complicated ones.

L (Coloured female): Ms F, like there's a lot of complicated words in Physics, so she would first teach us the easy words and then the complicated words so it's not like confusing, like we know which words is what.

L (Coloured male): It's like some teachers they just like throwing with big words and facts all the time almost like you should just remember it, like your brain is like some tape recorder that you can just replay later and learn it, whereas other teachers like give you a funner way to remember it, or they break it down, like in history there is like big words and Mr W. will give you a smaller word in place of it.

Teacher qualities. When students discussed how they did not find physical student-teacher congruence helpful, they spoke of qualities that made a good teacher, one that they would benefit to learn from. Teacher qualities that students enjoyed were consistent across groups. The main qualities were that a good teacher is kind, caring, patient, respectful, competent and motivating. The extracts below illustrate some of the teaching qualities that students valued.

L (Black African female): I think like she's very patient, like especially when I don't understand something, she'll like make sure I understand, till the way I should be understanding it, that's why I think her patience is very, very remarkable

L (White female): Um I think my favourite teacher was my English teacher last year, Ms N, um I liked that she was always kind and respectful and she never raised her voice, she was always nice to everyone

L (Black African female): He teaches history, history is not my favourite subject but from this year I've learnt to love it because of the way he teaches it, he makes you feel like you in the moment

Although student-teacher congruence has successfully mitigated ST in other countries, participants in our sample did not believe it would be helpful. It is possible that this is because students did not believe stereotypes in the first place and thus did not feel that a potential mitigator of ST was necessary. Also, it is possible that the counter-narrative of apartheid and beliefs of equality in people suggest an overall view that there is no reason to preference one person over another based on physical characteristics. The findings did not support the hypotheses that students would prefer physically congruent teachers.

As previously discussed, the sample of students did not unwittingly believe stereotypes or endorse ones that honoured them. This could be unusually mature thought processes for students of their age, possibly due to our country's history.

Since students described the qualities that made a good teacher and felt a good teacher would improve their maths performance, study 2 used an instrument that captured the teacher qualities that students spoke of to examine whether this could mitigate ST.

Study 2: Rationale, Specific Aims, and Hypotheses

Due to study 1's findings, race or background-based stereotypes associated with maths was not examined further, since students were not aware of such stereotypes. Surprisingly, girls who were aware of the stereotype that boys are better than girls at maths did not believe it and claimed it was a motivating pressure. The girls seeing the stereotype as helpful opposed much research suggesting otherwise. I was not convinced that they were unaffected by ST, considering evidence that girls' beliefs in stereotypes did not moderate their susceptibility to the threat (Huguet & Régner, 2009). Therefore, I wanted to examine more objective evidence from quantitative methods to determine whether girls were negatively affected by ST.

Studies showed that the more one valued maths (Woodcock, Hernandez, Estrada, & Schultz, 2012) and experienced anxiety (Garín, López, & Alonso, 2017), the more chance there was of experiencing ST. Girls with high gender identity (Wout, Danso, Jackson, & Spencer, 2008) and consciousness of gender-stereotypes (Cokley et al., 2015) were more likely to experience ST than those with low identity or consciousness. Research suggested the

importance of future studies considering whether established moderators of ST are additive or interact, possibly resulting in experience of ST in degrees (Picho & Brown, 2011).

Participants in study 1 did not see potential benefits from having physically congruent teachers. Rather they spoke of the emotional qualities of teachers they liked. In a seminal work, Steele (1997) discussed the role that “optimistic” teacher-student relationships could have in mitigating ST: teachers (authority figures) could assist affected students by actively disregarding stereotypes. Teachers could help mitigate ST through sharing their confidence in stigmatized students’ abilities and providing care and support. There is scant recent research that examines teacher-student relationship as a mitigator of ST, however one study found that optimistic teacher-student relationships benefited Afro-American students experiencing ST. The relationships made students feel valued and secure such that they felt less threatened by ST (Taylor & Antony, 2000). These relationships were beneficial regardless of physical congruence - those who had positive relationships with physically incongruent teachers were highly satisfied. Therefore, examining the quality of relationships students had with their maths teachers were likely to mitigate ST, thereby improving maths performance.

Aims of study 2:

1. Analyse the extent to which students were negatively affected by ST (consisting of study attitude, maths anxiety, gender identity and gender consciousness),
2. Investigate the effect teacher-student relationship had on maths performance,
3. Determine whether teacher-student relationship mitigated ST, thereby improving maths performance.

Hypotheses for study 2:

1. Maths marks of girls would be significantly lower than those of boys,
2. Significant negative relationships would exist between maths marks of girls and study attitude, maths anxiety, gender identity or gender consciousness, according to ST theory,
3. There would be a positive relationship between maths marks and teacher-student relationship,
4. Positive teacher-student relationships would moderate the relationship between ST variables and maths marks.

Study 2: Methods

Design and Setting

Study 2 used quantitative methods. All measures were administered online in a survey self-report style using the SurveyMonkey platform (www.surveymonkey.com). All items

were self-rated on a five-point Likert-type scale. Data collection took place in computer labs at participating schools.

Participants

Students were recruited simultaneously for studies 1 and 2 before study 1 took place. The total sample size after exclusions (Figure 1) was $n = 198$.

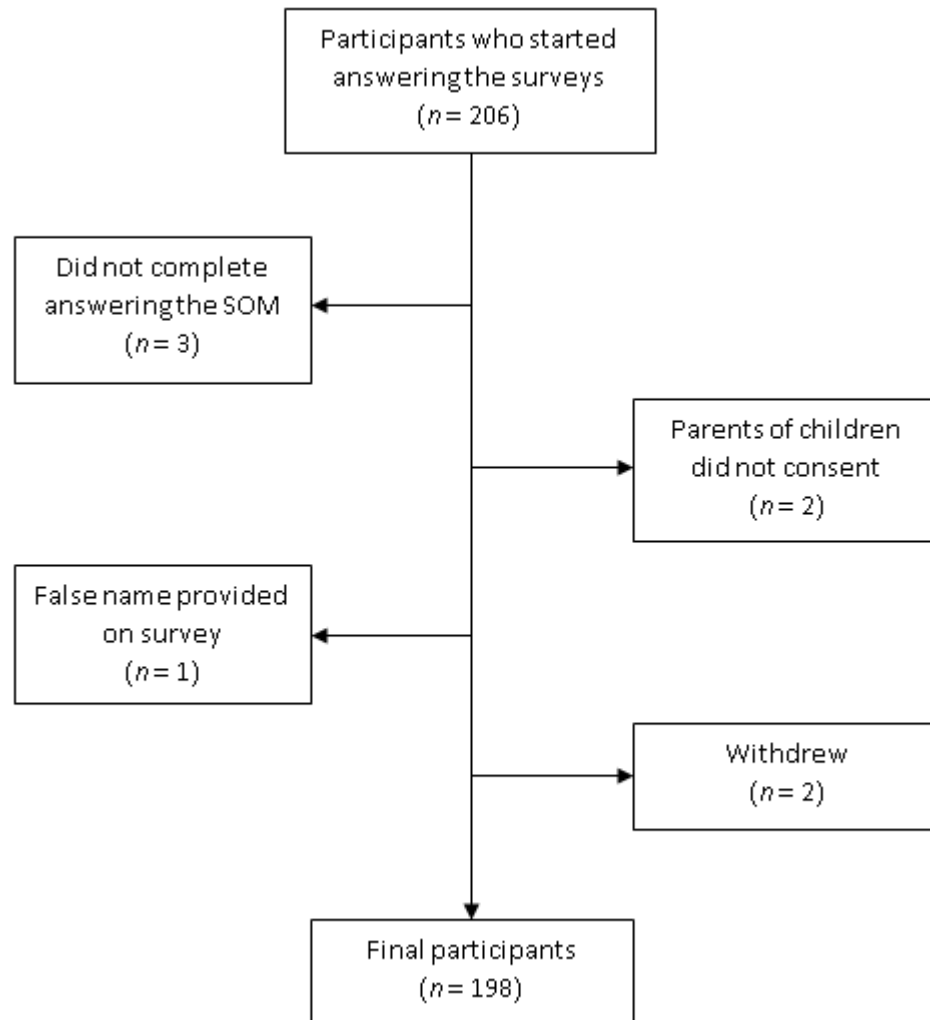


Figure 1. Reasons why participants were excluded from analysis. SOM = Study Orientation in Mathematics.

Power analysis. G*power calculated that to obtain power of .80 for linear multiple regression, with six predictors, $\alpha = .05$, and Cohen's $f = .25$ (medium) one would need a sample size of $n = 62$. As analysis progressed linear mixed-effects models were used. However, power estimates are not established for linear mixed-effects models, so the estimate based on linear multiple regression was accepted.

Measures and Materials

Social Identities and Attitudes Scale (SIAS). There were no scales that definitively measured how much someone experienced ST, however there were measures that determined

people's level of risk for experiencing it. The full scale consisted of 30 statements that were rated on a 7-point Likert-type scale ranging from strongly disagree to strongly agree. The SIAS was modelled by six factors: maths identification, ethnic identification, ethnic consciousness, gender identity, gender consciousness and negative affect (Picho & Brown, 2011). The SIAS has been used successfully before (Picho, 2016), however not in SA. Study 1 found that gender-related stereotypes were most prevalent. However, I could not find a suitable ST survey measure that examined maths-related gender stereotypes solely. Thus, I used the gender identity and gender consciousness factors from the SIAS (Appendix F). Both factors had strong reliability: gender identification (Cronbach's $\alpha = .81$, 95% CI [.76, .85]) and gender consciousness (Cronbach's $\alpha = .88$, 95% CI [.85, .91]). All items in the scale had content validity indices of .8 and above (Picho & Brown, 2011).

Study Orientation in Mathematics (SOM). This questionnaire looks at factors pertaining to maths achievement. It was developed in SA and normed on a South African population. There were five fields for Grade 9 students in the questionnaire: study attitude in maths, maths anxiety, study habits, problem-solving behaviour and study milieu (Maree, Claassen, & Prinsloo, 1998). I used the first two fields in the survey, study attitude in maths and maths anxiety (Appendix G). The study attitude field corresponded to the maths attitude subscale in the SIAS and was more comprehensive. The maths anxiety field corresponded to the negative affect in the SIAS and was more comprehensive. These fields had satisfactory reliability coefficients for Grade 9 learners: study attitude in maths (Cronbach's $\alpha = .75$) and maths anxiety (Cronbach's $\alpha = .77$). The intercorrelation between these two fields was satisfactorily low (.39) which indicated good discriminant validity.

Teacher-student relationships scale. This scale measures the positive and negative aspects of the relationship between a teacher and student and uses perspectives of both parties (Brinkworth, McIntyre, Juraschek, & Gehlbach, 2018). The scale was developed and used successfully in the United States (Brinkworth et al., 2018). The scale consists of positivity and negativity subscales. The items in the student scale corresponded well with what students said in study 1, about what they valued in a teacher. Since I was only interested in students' perceptions of their maths teachers, I used the student scale (Appendix H). There was good reliability for both student subscales: positivity (Cronbach's $\alpha = .92$, 95% CI [.91, .93]) and negativity (Cronbach's $\alpha = .78$, 95% CI [.75, .81]).

Procedure

Participants were gathered in a computer lab at their school and reminded of ethical considerations. They were briefed on how to correctly submit the surveys. Their computers

were set up beforehand such that both surveys were open on the computer screens when they arrived. Once they completed the surveys, they were debriefed and encouraged to ask questions they may have had about the research or the surveys they completed.

Data Management and Statistical Analyses

Statistical analysis was performed in SPSS (version 25) and R (version 3.6.1). SPSS was used to clean the data and create variables from items. R was used for the main analyses. Statistical significance, α was set at .05 and all assumptions were met.

Descriptive statistics. To illustrate sample characteristics, I calculated descriptive statistics for the sociodemographic and outcome variables.

Factor analyses. Because the SIAS and the teacher-student relationships scale had not been used in SA and the SOM was normed in SA many years ago, I ran factor analyses to determine the factor structure in the current sample and check for poor items. In the SOM, study attitude and maths anxiety were considered distinct factors, similarly in the SIAS for gender identity and gender consciousness and likewise for the positivity and negativity subscales of the teacher-student relationships scale. Therefore, I checked that the above factor structures held true in relation to the current dataset by performing a confirmatory factor analysis on each measure. Thereafter, I derived the outcome variables by summing items corresponding to each factor.

Main analyses. A two-tailed independent samples t-test was performed to determine if there was any significant difference between maths marks across genders.

Since the participants came from schools with different fees, resources, locations and academic performance, there would likely be clustering in the data. Therefore, linear mixed-effects modelling was used (an extension of linear regression). This approach incorporated fixed effects (relationships between predictors and dependent variables) and random effects of the school that participants attended to account for correlated data within schools. The benefits of this approach were that one would have the statistical power of the full sample without excluding information pertaining to school differences which would explain more variance. If the random effect was ignored, there would have been risk of over-generalising results and possibly not detecting significant differences between schools. The simplest form of linear mixed-effects modelling known as a random intercept model was used to account for the clustering of school data, while assuming the effects (slopes of regression lines) of predictor variables would be consistent across schools.

The four outcome variables and the categorical gender variable were considered fixed effects, while school was considered a random effect. All regression assumptions were met,

however maths anxiety and teacher-student relationship variables were moderately skew. A log transformation on maths anxiety was performed, which reduced skewness from .53 to -.1. Applying transformations to the teacher-student relationship variable increased the skewness so I kept the variable in its original form, since moderate skewness was acceptable.

Since I was going to examine potential moderators, I centered all the variables. I was interested to investigate whether teacher-student relationship could mitigate the effects of ST through interacting with any of the predictor variables. Since there was no knowledge of where the interaction was most likely to be found, all possible interactions were examined. I followed a top-down approach, starting with the most complex model, a six-way interaction and continued simplifying the model until a significant effect was found (Zuur, Ieno, Walker, Saveliev, & Smith, 2009). Thereafter, I refined the model until the model only consisted of significant effects.

Study 2: Results

Sample Characteristics

I summarised the sample characteristics with regards to age, gender, school and outcome variables (Appendix I). All participants were aged between 13 and 16 and there were 121 girls and 77 boys in the full sample.

Factor Analyses

SIAS. One item from the gender identity subscale, “My gender is central in defining who I am” was removed from the analysis. This item had a poor factor loading of .23 and low communality of .08 (Appendix J, Table J1). Many participants had queries regarding this item while answering the survey. It is possible that some participants did not understand the word “central” in the context of the item and therefore struggled to answer it meaningfully. One item from the gender consciousness subscale, “My gender affects how people act towards me” was removed from the analysis because it loaded on both factors (Appendix J, Table J1). The item appeared simple to understand, but perhaps the neutrality of the item statement made it unclear. I think if it was worded as clearly negative or positive it would have been a better item. The omega total coefficient is a reliability measure based on variance decomposition that is conceptually similar to Cronbach’s alpha but is less restrictive in its assumptions and leads to more accurate reliability estimates (McNeish, 2018). Although the omega total coefficient reduced slightly from .76 to .72 with the removal of the items, all four prominent fit indices improved such that all indices supported the two-factor structure (Appendix J, Table J2).

SOM. I removed three items from the study attitude subscale from the analysis (Appendix J, Table J3). One of these items were double-barrelled and queried whether students did other tasks during boring maths lessons such as “writing letters”. This item loaded higher on the maths anxiety factor than the study attitude factor. I think the example of writing letters was a poor choice of wording since it is unlikely that young people today would resonate with it. The other two items loaded predominantly on the maths anxiety factor as well as partially on the study attitude factor. One item used the terms “sleepy, tired, or bored” synonymously, which may have led to mixed results due to the subtle differences between the adjectives. For instance, students with a high study attitude may still get tired if they have a lot of maths work to do, although they are unlikely to become bored. The other item considered concentration in relation to study attitude, however one could make an argument that regardless of one’s study attitude, anyone can struggle to concentrate after they have worked for a while.

I removed four items from the maths anxiety subscale from the analysis. One of these items had a factor loading of .09 with a p-value that was not significant, indicating a poor item and a communality of .03 (Appendix J, Tables J3 & J4). At face value the item did not sound like a maths anxiety item to me and I think participants would have been unclear about the context of the statement. The item that spoke about needing to go to the toilet during maths classes had a very poor communality of .08 and a poor factor loading. Although I understand that in theory one needs the toilet more often when they are anxious, I doubt most of the participants would have such a high anxiety, so they probably thought the item was quite arbitrary. The item that questioned whether students perspired more in maths than other classes loaded on the study attitude factor. When participants were doing the survey, some were unsure of what the word “perspire” meant, I think this caused some confusion. I am also sceptical about whether students would be aware of when they sweat more than usual. The other item which was concerned with students struggling due to misreading questions loaded onto both factors. I think that if participants did struggle with some maths sums, but not due to misreading they would not know how to answer the item. Although removing the items reduced the omega total coefficient slightly from .89 to .88, it caused great improvement in the fit indices (Appendix J, Table J5). Before removal, none of the four indices indicated acceptable fit, but after the removal three of the indices indicate acceptable model fit for the two-factor solution.

Teacher-student relationships scale. The confirmatory factor analysis showed support for the two-factor solution consisting of a positivity and negativity subscale as

expected. The goodness of fit test was significant, $X^2(76) = 111.61, p = .005$, suggesting poor model fit, however chi-squared is not a good measure for large samples. The confirmatory fit index was 0.96, root mean square error of approximation was 0.05 and standardised root mean square residual was 0.05, which all fell within good fit levels in support of the two-factor structure. The omega total coefficient was .90 for the teacher-student positivity subscale used.

Hypothesis 1

For the full sample, there was no significant difference between girls' ($M = 47.29, SD = 20.59$) and boys' ($M = 50.82, SD = 19.90$) maths marks, $t(196) = 1.19, p = .235$. Within each of the schools there were no significant gender differences in maths marks: school 1 ($t(47) = .16, p = .877$), school 2 ($t(39) = -.54, p = .595$), school 3 ($t(46) = -.32, p = .752$) and school 4 ($t(58) = .33, p = .745$).

Hypothesis 2

There was a significant positive relationship between study attitude and maths marks for boys and girls (Figure 2). There was a significant negative relationship between maths marks and maths anxiety for boys, but there was no significant relationship for girls (Figure 3). There was no relationship between the gender identity and gender consciousness variables for boys or girls. I tried splitting the data by maths achievement levels, but there were still no significant relationships for the subgroups.

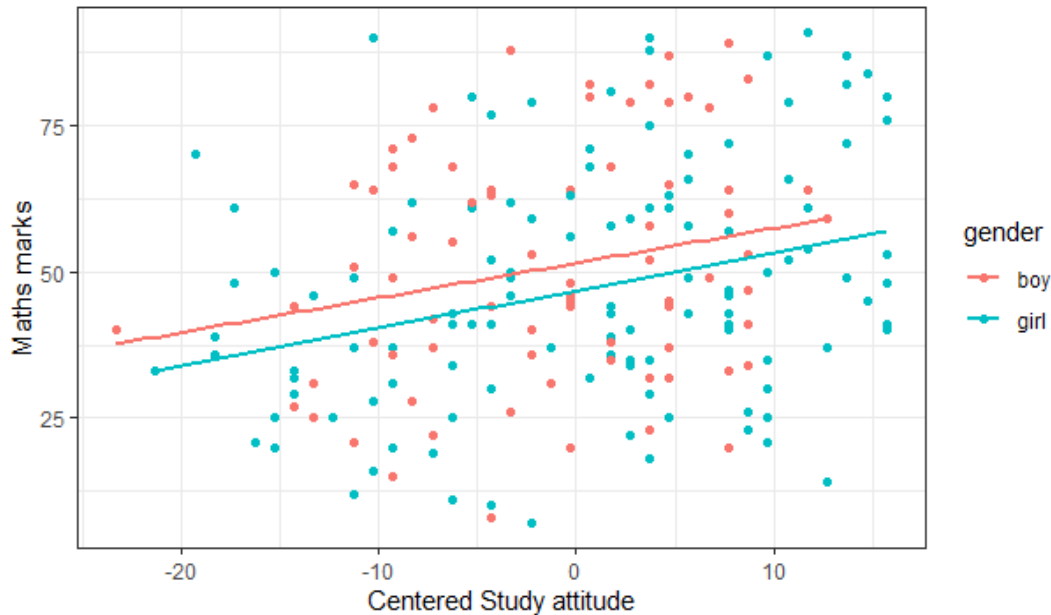


Figure 2. Relationship between study attitude and maths marks for boys ($N = 77$) and girls ($N = 121$).

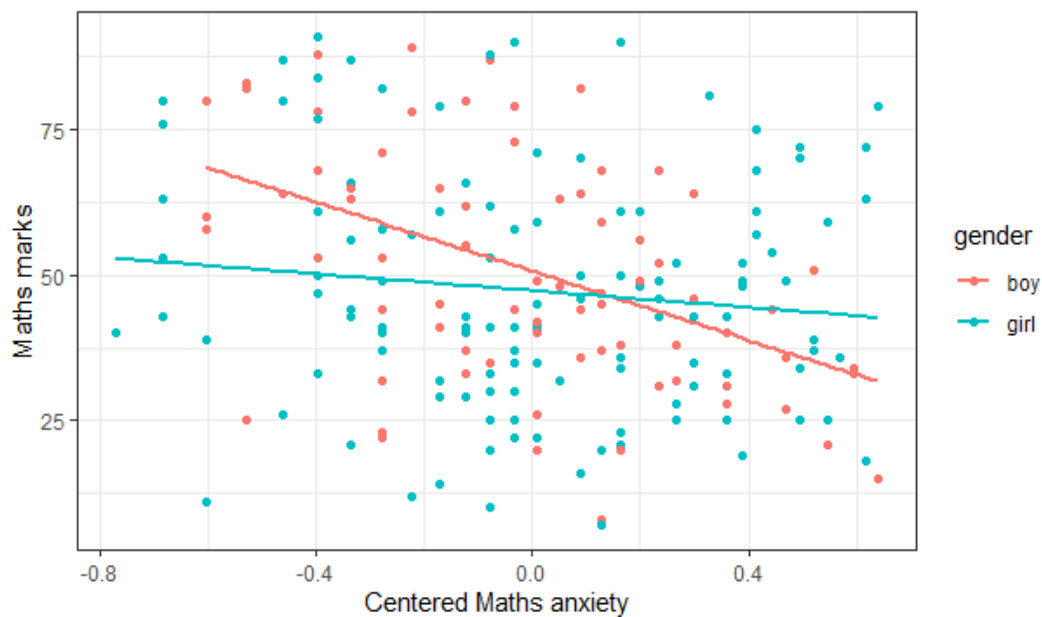


Figure 3. Relationship between maths anxiety and maths marks for boys ($N = 77$) and girls ($N = 121$).

Hypothesis 3

There was no significant relationship between teacher-student relationship and maths marks of boys or girls (Figure 4). I tried splitting the sample in half according to maths marks, but neither of the subgroups had significant relationships.

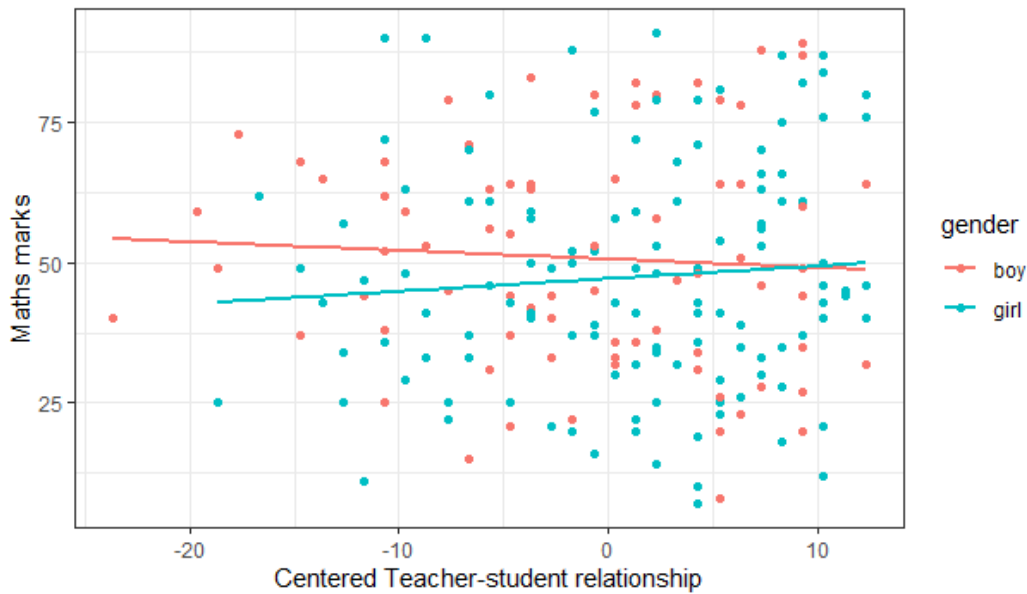


Figure 4. Relationship between maths marks and teacher-student relationship for boys ($N = 77$) and girls ($N = 121$).

Hypothesis 4

There were no significant interactions between teacher-student relationship and any other ST variables (Appendix K).

The final refined model consisted of two main effects of study attitude and maths anxiety. Study attitude had a positive relationship with maths marks (Figure 5), while maths anxiety had a negative relationship (Figure 6), corresponding with expectations.

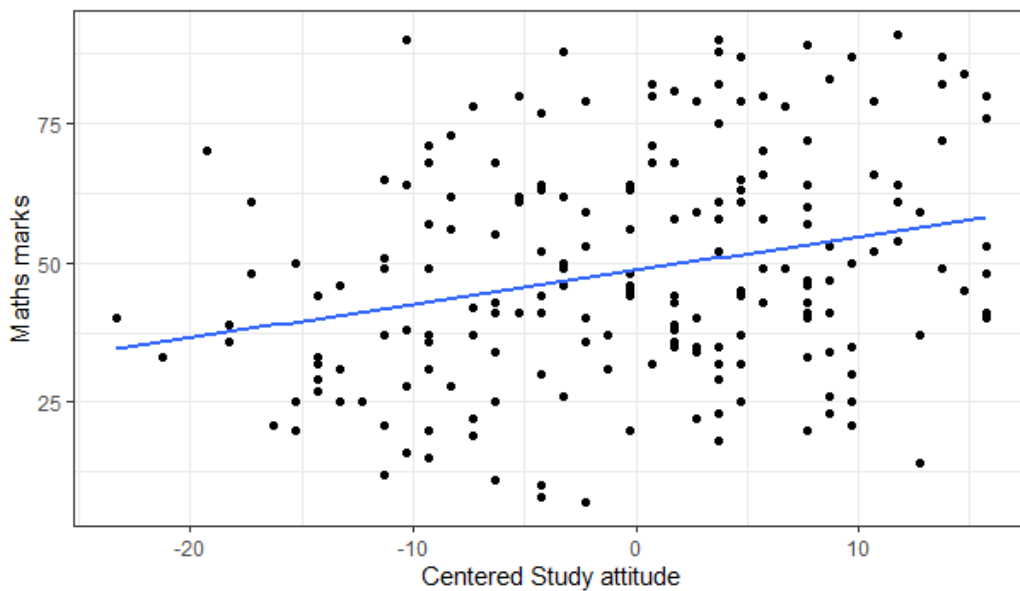


Figure 5. Relationship between study attitude and maths marks ($N = 198$).

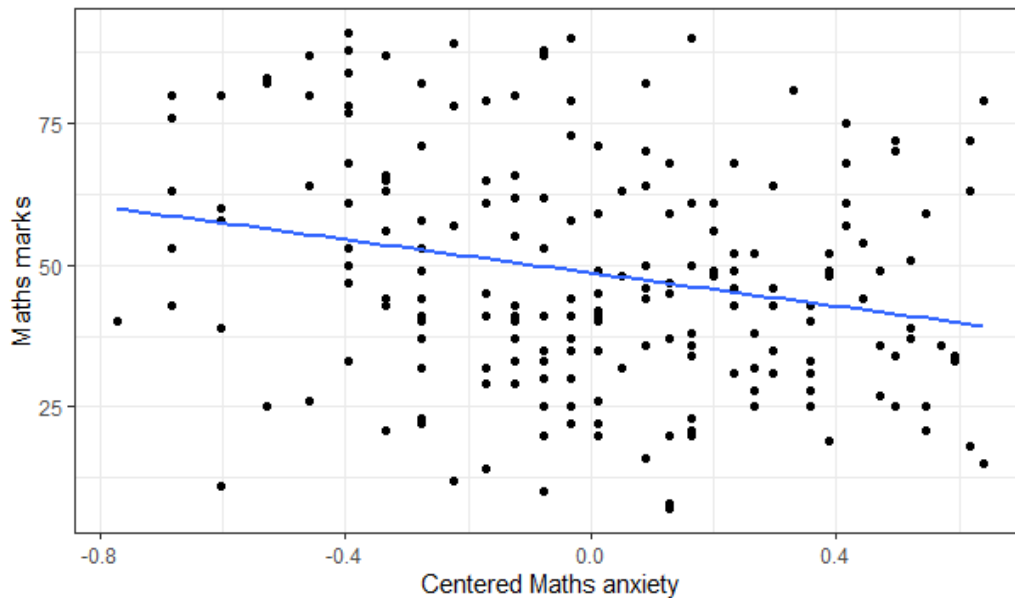


Figure 6. Relationship between maths anxiety and maths marks ($N = 198$).

The final model consisting of only significant main effects is seen in Table 2. The predictors tab of the table refers to the significant fixed effects and the random effects tab refers to the influence of school clustering. The variance explained without regarding school as a random effect was 16%. The variance explained increased substantially to 47% when accounting for the random effect.

Table 2.
Regression model summary

| Predictors | <i>Estimates</i> | <i>std. Error</i> | <i>CI</i> | <i>P</i> |
|------------------------------------|------------------|-------------------|----------------|----------|
| (Intercept) | 48.37 | 6.34 | 35.93 – 60.80 | <.001*** |
| Study attitude | 0.70 | 0.14 | 0.43 – 0.98 | <.001*** |
| Maths anxiety | -14.73 | 3.68 | -21.94 – -7.52 | <.001*** |
| Random Effects | | | | |
| σ^2 | | 268.82 | | |
| τ_{00} school | | 155.38 | | |
| ICC | | 0.37 | | |
| N_{school} | | 4 | | |
| Observations | | 198 | | |
| Marginal R^2 / Conditional R^2 | | 0.16 / 0.47 | | |

Note. Predictor variables are centered and a log transformation was applied to maths anxiety. CI = confidence interval; ICC = intraclass correlation coefficient.

* $p < .05$. ** $p < .01$. *** $p < .001$. All listed p -values are two-tailed.

The intraclass correlation coefficient showed that 37% of the variability in maths marks was between schools. Thus, after determining the best model for the whole sample, it was necessary to examine the random effects plot to see how significant the model was for schools individually. The vertical line at $x = 0$ is useful for judging significance of models; horizontal confidence intervals that cross that line are not significant, and those that do not are significant. Figure 7 showed a trend: as school fees increased, the model decreased in its significance, for all except school 3. This school was very different to the others, it had the highest average maths mark and highest bachelor pass rate. The school was known to focus on maths and science subjects and thus there may be some unique characteristic of students attending the school that explains why it differs from others. Study attitude and maths anxiety were both significant predictors at schools 1 and 3, while only study attitude was significant at school 2 and neither at school 1.

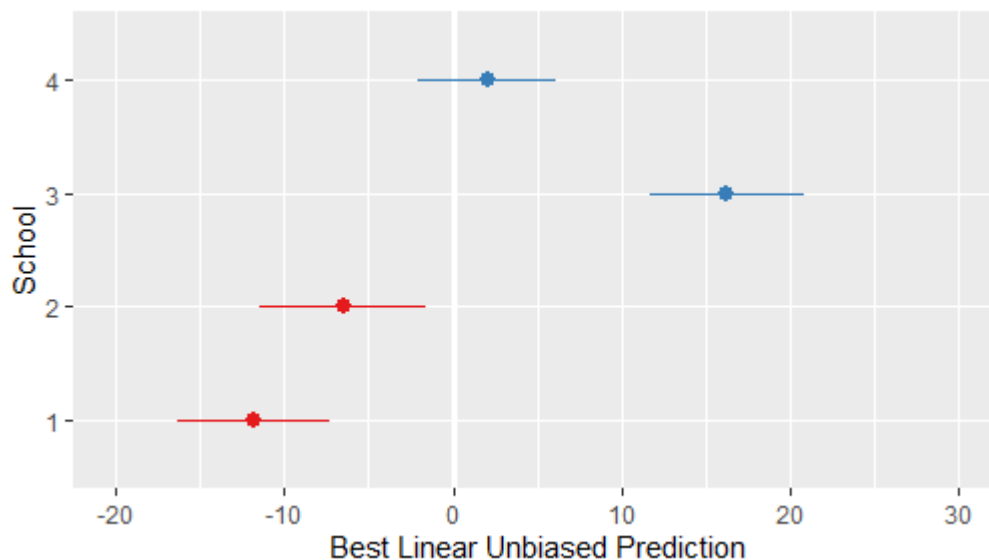


Figure 7. Random effects of school: school 1 ($N = 49$), school 2 ($N = 41$), school 3 ($N = 48$) and school 4 ($N = 60$). School fees increase as school number increases.

Study 2: Discussion

Hypothesis 1

I found no significant gender differences in maths marks for the full sample and individual schools. Studies in other countries found that girls performed significantly worse than boys due to ST. However, significant underperformance of girls, a common outcome of ST, was not found in our sample. This corresponded with what girls said in discussion groups: being aware of gender-based maths stereotypes did not hinder their performance. Similarly, another study in SA found a lack of gender differences in maths performance in the poorest 80% of schools. However, they found significant gender differences in the richest

20% (Shepherd, 2017). School 4 in the present sample fell within the richest 20% of schools in SA but did not support the findings of gender differences.

Another consideration is that ST might not be present at this stage of student's lives (Grade 9). Since ST has affected university women, I think effects of ST may manifest in higher grades. Evidence also showed that more girls drop to maths literacy in Grade 10-12, particularly in the richest 20% of schools (van der Berg et al., 2019), which I think is possibly a result of ST (not investigated in this study).

Hypothesis 2

The relationships between girls' maths marks and the variables that made up ST susceptibility were all different to what the theory predicted. The higher one's study attitude, the more at risk one should be of experiencing ST. However, instead of seeing a negative relationship between study attitude and maths marks for girls, there was a significant positive relationship. Theoretically, the higher a girl's maths anxiety, the more at risk they should be of experiencing ST. The results for maths anxiety were interesting because while there was a negative relationship between boys' maths anxiety and their marks, there was no significant relationship between girls' maths anxiety and their marks. These findings show that girls in our sample did not suffer the negative effects of ST. This aligned with what girls said in study 1. They felt that knowing the gender-based stereotype did not put unhelpful pressure on them - most felt it encouraged them to work hard. This sentiment could make sense of the lack of relationship between girls' maths anxiety and marks. For instance, some girls who felt the stereotype was a positive pressure may have experienced optimal anxiety levels (according to the Yerkes-Dodson law) that helped them perform to their best ability (Keller, 2007). However, other girls may have performed poorly due to very high anxiety. If both of these interpretations held at the same time it could explain why the data points look very scattered, as if there was no relationship. There may be other factors that could explain the difference between optimal anxiety and detrimental anxiety – research has shown that perseverance and resilience can be attributed to students who perform well despite awareness of stereotypes (McGee & Bentley, 2017).

Hypothesis 3

It was unexpected that the relationship between students and their maths teachers would have no effect on their maths marks. The students in study 1 spoke highly of the importance of having a good teacher and how teacher qualities could improve the learning process. Research also showed evidence for positive teacher-student relationships mitigating ST and increasing maths performance. Although students' relationships with their teachers

did not statistically influence their maths marks, students' appreciation of their teachers may have qualitatively made them feel like their relationship with their teacher enhanced their learning process. Also, the teacher-student relationship measure focused on students' relationships with their current maths teacher, however historical relationships may also have influenced their current performance and was not accounted for.

Hypothesis 4

Although there were no significant interactions involving teacher-student relationship, this should be interpreted with caution. The aim was to see if teacher-student relationship could mitigate ST, however results showed that girls were not negatively affected by ST. Therefore, it did not make sense to interpret the effect of the potential relationship moderator in this sample. One should not rule out the possibility of teacher-student relationship being a moderator in samples that experience ST.

Limitations and Directions for Future Research

One should be cautious about drawing conclusions from the studies as there were a few limitations. Firstly, there were arguably better methods of identifying effects of ST. For instance, many studies used stereotype priming before a maths-related task was performed which elicited ST (Jamieson & Harkins, 2012). This would have been a more reliable and objective manner of investigating the effects of ST compared to self-measure reports. However, I also think that a priming scenario would be more contrived, whereas this method was more realistic.

Secondly, the teacher-student relationships scale was limited in capturing the role that teachers may have played in students' maths performance. Despite the scale consisting of teacher qualities that participants spoke of as having a positive effect on their learning, no effect of teacher-student relationship was found. However, the scale did not measure teacher competency - participants in study 1 also said that having teachers who could explain concepts effectively was beneficial. If study 2 had found ST to be present it is doubtful that this measure of teacher-student relationships would have been able to produce a significant mitigator. Future studies should incorporate teacher-student relationships and perceived teacher competency to encompass teachers' impacts on students' maths performance more fully.

Lastly, maths performance was the only outcome of ST examined in this research. However, there may be other significant outcomes of ST, possibly seen in behaviours of learners, such as how willing girls are to volunteer answers in class or who they perceive to

be the smartest students in their maths class. Studies in SA should explore other manifestations of ST that alter behaviour and perceptions of those affected.

Summary and Conclusion

Globally students struggle with maths and research shows that students of colour and females have a higher chance of underperforming than their counterparts - one possible explanation is ST. Limited research on ST has been done in SA, therefore I explored whether it affected students and examined a possible mitigator in four Western Cape schools.

Students had heard of stereotypes that men are better than women at maths but did not believe them. Girls felt they were not hindered by stereotypes, rather it was motivating. Students felt positive student-teacher relationships were more important than physical student-teacher congruence. There were no significant gender differences in maths performance in our sample. Unexpectedly, teacher-student relationship was insignificant.

In conclusion, we did not detect effects of ST on girls and the perceived teacher-student relationship did not influence maths performance. Stereotype threat does not seem to be a significant impediment to maths performance in the four schools we surveyed.

References

- Bedyńska, S., Krejtz, I., & Sedek, G. (2019). Chronic stereotype threat and mathematical achievement in age cohorts of secondary school girls: Mediation role of working memory, and intellectual helplessness. *Social Psychology of Education, 22*(2), 321–335. doi:10.1007/s11218-019-09478-6
- Berger, R. (2015). Now I see it, now I don't: Researcher's position and reflexivity in qualitative research. *Qualitative research, 15*(2), 219-234. doi: 10.1177/1468794112468475
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative research in psychology, 3*(2), 77-101. doi: 10.1007/s11218-019-09478-6
- Brinkworth, M. E., McIntyre, J., Juraschek, A. D., & Gehlbach, H. (2018). Teacher-student relationships: The positives and negatives of assessing both perspectives. *Journal of Applied Developmental Psychology, 55*, 24–38. doi: 10.1016/j.appdev.2017.09.002
- Chukhray, I. (2015, August). *Race and gender teacher-student congruence effects on student achievement in racially segregated schools*. Paper presented at the 2015 annual meeting of the American Sociological Association, Chicago, IL.
- Cokley, K., Awad, G., Smith, L., Jackson, S., Awosogba, O., Hurst, A., ... Roberts, D. (2015). The roles of gender stigma consciousness, impostor phenomenon and academic self-concept in the academic outcomes of women and men. *Sex Roles, 73*(9-10), 414-426. doi: 10.1007/s11199-015-0516-7
- Cronje, F., & Matwasa, U. (2018). *Fast facts: Education the single greatest obstacle to socio-economic advancement in South Africa*. Johannesburg, South Africa: Centre for Risk Analysis.
- Engelbrecht, A. (2008). The impact of role reversal in representational practices in history textbooks after Apartheid. *South African Journal of Education, 28*(4), 519-542.
- Fairlie, R. W., Hoffmann, F., & Oreopoulos, P. (2014). A community college instructor like me: Race and ethnicity interactions in the classroom. *American Economic Review, 104*(8), 2567-2591. doi: 10.1257/aer.104.8.2567
- Foley, A. E., Herts, J. B., Borgonovi, F., Guerriero, S., Levine, S. C., & Beilock, S. L. (2017). The math anxiety-performance link: A global phenomenon. *Current Directions in Psychological Science, 26*(1), 52-58. doi: 10.1177/0963721416672463
- Fox, L. (2016). Seeing Potential: The Effects of Student-Teacher Demographic Congruence on Teacher Expectations and Recommendations. *AERA Open, 2*(1), 1-17. doi: 10.1177/2332858415623758

- Garín, D. P., López, A. B., & Alonso, F. M. (2017). Revealing stereotype threat effects and women's maths performance: The moderating role of mathematical anxiety. *Revista de Psicología Social*, 32(2), 287-300. doi: 10.1080/02134748.2017.1291746
- Graven, M. H. (2013). Poverty, inequality and mathematics performance: The case of South Africa's post-apartheid context. *ZDM*, 46(7), 1039-1049. doi: 10.1007/s11858-013-0566-7
- Howie, S. J. (2003). Language and other background factors affecting secondary pupils' performance in mathematics in South Africa. *African Journal of Research in Mathematics, Science and Technology Education*, 1(7), 1–20. doi: 10.1080/10288457.2003.10740545
- Huguet, P., & Régner, I. (2009). Counter-stereotypic beliefs in math do not protect school girls from stereotype threat. *Journal of Experimental Social Psychology*, 45(4), 1024-1027. doi:10.1016/j.jesp.2009.04.029
- Hyde, J. S., Lindberg, S. M., Linn, M. C., Ellis, A. B., & Williams, C. C. (2008). Gender similarities characterize math performance. *Science*, 321(5888), 494-495. doi: 10.1126/science.1160364
- Jamieson, J. P., & Harkins, S. G. (2012). Distinguishing between the effects of stereotype priming and stereotype threat on math performance. *Group Processes & Intergroup Relations*, 15(3), 291-304. doi: 10.1177/1368430211417833
- Joshi, E., Doan, S., & Springer, M. G. (2018). Student-teacher race congruence: New evidence and insight from Tennessee. *AERA Open*, 4(4), 1-25. doi: 2332858418817528.
- Kapitanoff, S., & Pandey, C. (2017). Stereotype threat, anxiety, instructor gender, and underperformance in women. *Active Learning in Higher Education*, 18(3), 213-229. doi: 10.1177/1469787417715202
- Keller, J. (2007). Stereotype threat in classroom settings: The interactive effect of domain identification, task difficulty and stereotype threat on female students' maths performance. *British Journal of Educational Psychology*, 77(2), 323-338. doi: 10.1348/000709906X113662
- Lai, T. (2015). Effects of student-teacher congruence on students' learning performance: A dyadic approach. *Social Science Quarterly (Wiley-Blackwell)*, 96(5), 1424–1435. doi: 10.1111/ssqu.12215
- Li, Q. (1999) Teachers' beliefs and gender differences in mathematics: a review. *Educational Research*, 41(1), 63-76. doi: 10.1080/0013188990410106

- Lim, J., & Meer, J. (2017). The impact of teacher–student gender matches: Random assignment evidence from South Korea. *Journal of Human Resources*, 52(4), 979–997. doi: 10.3368/jhr.52.4.1215-7585R1
- Maree, J. G., Claassen, N. C. W., & Prinsloo, W. B. J. (1998). Development of a study orientation questionnaire in mathematics. *South African Journal of Psychology*, 28(2), 101. doi: 10.1177/008124639802800207
- McGee, E. (2018). “Black genius, Asian fail”: The detriment of stereotype lift and stereotype threat in high-achieving Asian and Black STEM students. *AERA Open*, 4(4), 1-16. doi: 2332858418816658
- McGee, E. O., & Bentley, L. (2017). The Troubled Success of Black Women in STEM. *Cognition and Instruction*, 35(4), 265–289. doi: 10.1080/07370008.2017.1355211
- McNeish, D. (2018). Thanks coefficient alpha, we’ll take it from here. *Psychological Methods*, 23(3), 412–433. doi: 10.1037/met0000144
- Mwamwenda, T. S. (2011). Teachers' gender stereotypes in South Africa: A case study, *Journal of Psychology in Africa*, 21(4), 611-613. doi: 10.1080/14330237.2011.10820508
- News24. (2019, Jan). Western Cape | Matric results. Retrieved from <https://matricresults.news24.com/2018/province/wc/school>
- Nkabinde, Z. P. (2016). Post Apartheid education in South Africa: A review of progress and pitfalls. *Reflections: Narratives of Professional Helping*, 22(2), 82–91.
- O’Brien, K. (2010). Road to equality in South African education: A qualitative study. *Online submission*, 1-33. doi: 10.33015/dominican.edu/2010.edu.04
- Picho, K. (2016). The psychosocial experience of high school girls highly susceptible to stereotype threat: A phenomenological study. *Journal of Educational Research*, 109(6), 608–623. doi: 10.1080/00220671.2015.1010192
- Picho, K., & Brown, S. W. (2011). Can stereotype threat be measured? A validation of the social identities and attitudes scale (SIAS). *Journal of Advanced Academics*, 22(3), 374–411. doi: 10.1177/1932202X1102200302
- Saft, E. W., & Pianta, R. C. (2001). Teachers’ perceptions of their relationships with students: Effects of child age, gender, and ethnicity of teachers and children. *School Psychology Quarterly*, 16(2), 125–141. doi: 10.1521/scpq.16.2.125.18698
- Shepherd, D. L. (2017). *Gender, self-concept and mathematics and science performance of South African grade 9 students* (BER Working Paper No. 11/2017).

- Smith, B., & McGannon, K. R. (2018). Developing rigor in qualitative research: Problems and opportunities within sport and exercise psychology. *International Review of Sport and Exercise Psychology*, *11*(1), 101–121. doi: 10.1080/1750984X.2017.1317357
- Spaull, N. (2013). Poverty & privilege: Primary school inequality in South Africa. *International Journal of Educational Development*, *33*(5), 436-447. doi: 10.1016/j.ijedudev.2012.09.009
- Spaull, N., & Kotze, J. (2015). Starting behind and staying behind in South Africa: The case of insurmountable learning deficits in mathematics. *International Journal of Educational Development*, *41*, 13-24. doi: 10.1016/j.ijedudev.2015.01.002
- Steele, C. M. (1997). A threat in the air: How stereotypes shape intellectual identity and performance. *American Psychologist*, *52*(6), 613–629. doi: 10.1037/0003-066x.52.6.613
- Taylor, E., & Antony, J. S. (2000). Stereotype threat reduction and wise schooling: Towards the successful socialization of african american doctoral students in education. *Journal of Negro Education*, *69*(3), 184–98. doi: 10.2307/2696231
- van der Berg, S., van Wyk, C., Selkirk, R., & Rich, K. (2019, September). *What we can learn from the data underlying the District Driven Dashboards (DDD)?*. Paper presented at the Quantitative Education Research Conference, Stellenbosch University.
- Wenglinsky, H. (2002). How schools matter: The link between teacher classroom practices and student academic performance. *Education Policy Analysis Archive*, *10*(12). 1-30. doi: 10.14507/epaa.v10n12.2002
- Woodcock, A., Hernandez, P. R., Estrada, M., & Schultz, P. (2012). The consequences of chronic stereotype threat: Domain disidentification and abandonment. *Journal of Personality and Social Psychology*, *103*(4), 635. doi: 10.1037/a0029120
- Wout, D., Danso, H., Jackson, J., & Spencer, S. (2008). The many faces of stereotype threat: Group-and self-threat. *Journal of Experimental Social Psychology*, *44*(3), 792-799. doi:10.1016/j.jesp.2007.07.005
- Xu, D., & Li, Q. (2018). Gender achievement gaps among Chinese middle school students and the role of teachers' gender. *Economics of Education Review*, *67*, 82-93. doi: 10.1016/j.econedurev.2018.10.002
- Yiu, H. L. E. (2013). The influence of student–teacher racial match on student–teacher closeness: A focus on Asian and Asian American students. *Asian American Journal of Psychology*, *4*(2), 126-135. doi: 10.1037/a0027785

Zuur, A., Ieno, E. N., Walker, N., Saveliev, A. A., & Smith, G. M. (2009). *Mixed effects models and extensions in ecology with R*. Springer Science & Business Media. doi: 10.1007/978-0-387-87458-6

Appendix A

Study 1: Discussion 1 Questions and Comment Cards

Table A1.

Discussion questions and comment cards

| | Discussion Question | Comment Card 1 | Comment Card 2 | Theory |
|---|---|--|---|-----------------------------------|
| 1 | When you think about someone who is achieving well in maths, what explanations do you have for why that person is doing well?* | Anyone can be good at maths, you just have to work hard. | Some people are just naturally good at maths and some people aren't. | Intelligence theory |
| 2 | When you think about someone who is not achieving in maths, what explanations do you have for why that person is not doing well? * | People are born with different talents. It's OK if you can't do maths, you will be able to do something else. | No one is born able to do maths but everyone can learn. | Intelligence theory |
| 3 | What have you noticed about stereotypes to do with maths ability? Do you think that there are higher expectations for some groups of learners based on their gender, race or background? | Everyone is expected to do well at maths. The gender, race or background of the learner does not matter. | There is a belief that some groups of people are worse at maths than others, based on their gender, race or background. | Stereotype threat |
| 4 | Do you think parents and maths teachers have different expectations for their learners' maths achievements depending on the school the learner attends? If so, why do they have these different expectations? | I think all parents and maths teachers expect good maths achievements from learners, regardless of the school the learner goes to. | I think that learners at schools with more money are expected to obtain better maths achievements than learners at schools with less money. | Stereotype threat |
| 5 | Do you think that maths needs to feel important in life and future careers for learners to really want to work on it? | maths is important to life and careers so everyone should strive to succeed at it. | If maths isn't important to your life or career plans then it's OK to not really work at it. | Ceiling effect |
| 6 | Thinking about people like you in your family and community, do you think it is worth the effort for people like you to work hard on maths? | In my family and community there are a lot of people with jobs that don't really require maths or people with no jobs at all. I'm not sure there is any point in my working hard at maths. | In my family and community maths is seen as really important. There is a clear expectation that young people will work hard at it. | Ceiling effect |
| 7 | Do you think that when the gender, race or background of the learner is similar to that of the teacher it makes learning easier? | I think similarities between learners and maths teachers make maths easier as they understand each other better. | I don't think it matters about the race, gender or background of maths teachers as long as they can teach well. | Teacher Student Congruence |
| 8 | What other things stop young people achieving at maths? | | | Open exploration |

| | | | | |
|----|--|--|--|-----------|
| 9 | What resources are available to you if you wanted to improve your maths? (prompt: school, community, family, friends, study strategies) | It is harder for some learners to do well at maths because they don't have the same resources as others. | Learners shouldn't make excuses about poverty stopping them from achieving at maths. | Resources |
| 10 | Which of the available resources are you using right now? | | | Resources |

Note. *Explore beliefs, actions, resources and environmental enablers and inhibitors.

Appendix B

University of Cape Town Ethical Approval Letter

UNIVERSITY OF CAPE TOWN



Department of Psychology

University of Cape Town Rondebosch 7701 South Africa
Telephone (021) 650 3417
Fax No. (021) 650 4104

20 November 2018

Katherine Morse
Department of Psychology
University of Cape Town
Rondebosch 7701

Dear Katherine

I am pleased to inform you that ethical clearance has been given by an Ethics Review Committee of the Faculty of Humanities for your study, *Closing the maths achievement gap: Exploring the applicability of growth mindset in South Africa*. The reference number is PSY2018 -066.

I wish you all the best for your study.

Yours sincerely

Lauren Wild (PhD)
Associate Professor
Chair: Ethics Review Committee

University of Cape Town
ΨPSYCHOLOGY DEPARTMENT
Upper Campus
Rondebosch

Appendix C
Ethical Approval Letter from Western Cape Education Department



Directorate: Research

Audrey.wyngaard@westerncape.gov.za

tel: +27 021 467 9272

Fax: 0865902282

Private Bag x9114, Cape Town, 8000

wced.wcape.gov.za

REFERENCE: 20181121–8975

ENQUIRIES: Dr A T Wyngaard

Mrs Katherine Morse
11 Camelia Close
Bergvliet
7864

Dear Mrs Katherine Morse

**RESEARCH PROPOSAL: CLOSING THE MATHS ACHIEVEMENT GAP:
EXPLORING THE APPLICABILITY OF GROWTH MINDSET IN SOUTH AFRICA**

Your application to conduct the above-mentioned research in schools in the Western Cape has been approved subject to the following conditions:

1. Principals, educators and learners are under no obligation to assist you in your investigation.
2. Principals, educators, learners and schools should not be identifiable in any way from the results of the investigation.
3. You make all the arrangements concerning your investigation.
4. Educators' programmes are not to be interrupted.
5. The Study is to be conducted from **02 April 2019 till 27 September 2020**
6. No research can be conducted during the fourth term as schools are preparing and finalizing syllabi for examinations (October to December).
7. Should you wish to extend the period of your survey, please contact Dr A.T Wyngaard at the contact numbers above quoting the reference number?

8. A photocopy of this letter is submitted to the principal where the intended research is to be conducted.
9. Your research will be limited to the list of schools as forwarded to the Western Cape Education Department.
10. A brief summary of the content, findings and recommendations is provided to the Director: Research Services.
11. The Department receives a copy of the completed report/dissertation/thesis addressed to:

The Director: Research Services
Western Cape Education Department
Private Bag X9114
CAPE TOWN
8000

We wish you success in your research.

Kind regards.

Signed: Dr Audrey T Wyngaard

Directorate: Research

DATE: 22 November 2018

Appendix D

Consent Letter to Principals of Participating Schools

Recruitment0: School Permission

UCT maths Research – Grade 8 & 9

kathsaili@gmail.com

Katherine Morse

061 390 4470

Dear Principal,

I am a researcher from UCT. I am researching maths performance, stress and school resources amongst Grade 8 and 9 learners. My hope is that my research will be able to assist struggling maths learners to improve their maths grades. The research is focused on the experiences of young people with maths. General feedback will be given to maths teachers about ways they may be better able to support maths learning in your school.

There is a substantial body of research from the USA that has demonstrated that beliefs about maths performance are related to grades. Very simple and cost-effective interventions have been developed to help young people change their beliefs about maths and improve their performance. To date, this research has not been applied in South Africa.

My research will be completed over 2019-2020 and aims to adapt the USA theory and interventions to our local setting. During the final phase of the research I will run an experimental intervention – “Maths Study Skills Workshop”. Half of the participants will be given the workshop informed by US theory and half will be given a general workshop.

I will need to collect maths report grades for participants in Study 2, 3 and 4. Additionally I will need maths baseline test grades for Grade 8, 2020 participants. If your school does not run a baseline maths test at the start of Grade 8, I can provide one for you. I will also need you or a senior staff member to complete an inventory of study support resources offered by your school or community.

There are four studies:

| | | | |
|----------------|------------|---------------------------|---|
| Study 1 | April 2019 | Grade 9 Discussion Groups | Two groups of eight learners meet twice after school for one hour to establish the scope of the research. |
| Study | May 2019 | Grade 8 & 9 Surveys | Two maths classes from each grade |

| | | | |
|----------------|----------------|---|--|
| 2 | | | complete surveys for 40 minutes to test the validity of the Mindset assessment tool. |
| Study 3 | September 2019 | Teacher Discussion Groups Pilot Intervention | Three teachers meet once after school for 60-90 minutes to assist with developing the intervention. 20 x grade 8 learners meet twice after school for 40 minutes for a either a Mindset Intervention Session or a Control Group Intervention. |
| Study 4 | February 2020 | Grade 8 Surveys and Intervention Roll Out | All Grade 8 maths learners complete surveys for 40 minutes. All grade 8 maths learners participate in Mindset Intervention Session or a Control Group Intervention. |

Personal details such as names and contact details will not be shared with anyone else. Your school name will also be kept confidential. Permission will be sought from parents and learners and they have the right to withdraw from the study at any time. The Western Cape Education Department and University of Cape Town Ethics Committee have given permission for this study. Those permissions are attached.

Kind regards,

Katherine Morse

Appendix E

Consent Letter for Parents and Students

UCT Maths Research – Grade 9 Class Surveys and Small Group Discussions with Katherine Morse

Dear Parents and Learners,

We are researchers from UCT. We are researching maths performance, stress and school resources. Your school has agreed that Grade 9 learners can assist with this research and your child's maths class has been selected to participate. Our hope is that this research will be able to assist struggling maths learners to improve their maths grades.

Young people who choose to participate in research generally do so because they are curious about the research process. Others participate because they see the problem with maths performance in their school and they want to contribute to a possible solution.

Learners will be asked to complete a questionnaire about their study approach to maths and maths resources available at your school, home or community. The questionnaire will take around 40 minutes to complete and will be completed during class time in early May 2019. Term 2 and Term 4 maths grades will also be collected from your school.

Additionally, some learners will be invited to two discussion groups about stress and maths, after school on Thursday or Friday in April.

- If you have questions or concerns about the research at any point please contact Katherine Morse, at kathsaili@gmail.com or whatsapp 074 9767097
- You and your child have the right to withdraw from the research at any time
- Personal details such as names and contact details will not be shared with anyone else.

.....

Parent Name: _____

1. I do/ do not (circle one) give permission for my child named below to participate in the UCT class maths Research with Katherine Morse & Layla Omar.

2. I do/ do not (circle one) give permission for my child named below to participate in the small group discussions with Katherine Morse & Layla Omar.

Signature: _____ Date: _____

Learner Name: _____

1. I do/do not (circle one) agree to participate in the UCT class maths Research.

2. I do/ do not (circle one) agree to participate in the small group discussions.

3. If you consent to the research please write your term 4 maths mark here: _____ %
(Please check your report, don't go from memory!)

Signature: _____ Date: _____

Appendix F

Social Identities and Attitudes Scale

Participants rated their agreement with the statements below by selecting one of the following terms: strongly disagree, disagree, neutral, agree, or strongly agree.

Gender identification:

1. My gender is central in defining who I am*
2. My identity is strongly tied to my gender
3. My gender influences how I feel about myself
4. My gender contributes to my self confidence

Gender consciousness:

5. My gender affects how people treat me
6. Members of the opposite sex interpret my behaviour based on my gender
7. My gender influences how teachers interpret my behaviour
8. My gender affects how people act towards me*
9. Most people judge me on the basis of my gender

*Bad items that were removed from analysis

Appendix G

Study Orientation in Mathematics

The items in this survey were copyrighted. Therefore, the items could not be listed here. To obtain the actual items one could order the assessment through the website:

<https://jvrafricagroup.co.za/catalogue/som>

Appendix H

Teacher-Student Relationships Scale

Participants rated their agreement with the statements below by selecting one of the following terms: rarely, sometimes, frequently, generally, or almost always.

1. I enjoy learning from my current maths teacher
2. My maths teacher says things that offend me
3. My current maths teacher is friendly
4. My maths teacher says encouraging things to me
5. My maths teacher is respectful towards me
6. I would be excited to have my maths teacher again next year
7. My maths teacher is caring towards me
8. I like my maths teacher's personality
9. I feel like I learn a lot from my maths teacher
10. Activities that my maths teacher plans for class are motivating
11. I ignore things my maths teacher says
12. My maths teacher makes me feel angry during class
13. During maths class, I talk when my teacher is talking
14. My maths teacher is unfair to me in class

Appendix I
Sample Characteristics

Table I.
Sample characteristics (N = 198)

| Variable | |
|------------------------------|---------------|
| Age (years) | |
| <i>M (SD)</i> | 14.54 (.67) |
| Range | 13-16 |
| Gender | |
| Female | 121 (61%) |
| Male | 77 (39%) |
| School | |
| School 1 | 49 (25%) |
| School 2 | 41 (21%) |
| School 3 | 48 (24%) |
| School 4 | 60 (30%) |
| Maths marks (%) | |
| <i>M (SD)</i> | 48.66 (20.35) |
| Range | 7-91 |
| Study attitude | |
| <i>M (SD)</i> | 39.29 (8.98) |
| Range | 16-55 |
| Maths anxiety | |
| <i>M (SD)</i> | 25.09 (8.27) |
| Range | 11-45 |
| Gender identity | |
| <i>M (SD)</i> | 9.96 (2.54) |
| Range | 3-15 |
| Gender consciousness | |
| <i>M (SD)</i> | 10.95 (3.04) |
| Range | 4-19 |
| Teacher-student relationship | |
| <i>M (SD)</i> | 32.70 (7.89) |
| Range | 9-45 |

Note. Means are presented, with standard deviations in parentheses. SOM = Study Orientation in Mathematics; SIAS = Social identities and Attitudes Scale.

Appendix J
Confirmatory Factor Analyses Tables

Table J1.

Factor loadings and communalities before removing items

| Item | g | Gender consciousness | Gender identity | Communalities |
|------|------|----------------------|-----------------|---------------|
| gi4 | 0.47 | | 0.56 | 0.54 |
| gi3 | 0.50 | | 0.44 | 0.47 |
| gi2 | 0.24 | | 0.45 | 0.29 |
| gi1 | | | 0.23 | 0.08 |
| gc5 | 0.29 | 0.32 | | 0.19 |
| gc9 | 0.38 | 0.46 | | 0.36 |
| gc8 | 0.54 | 0.44 | 0.23 | 0.53 |
| gc7 | 0.33 | 0.39 | | 0.26 |
| gc6 | 0.32 | 0.51 | | 0.37 |

Note. Factor loadings below 0.2 were suppressed.
Issues that suggest poor items are denoted in bold.

Table J2.

Effect of removing items from SIAS on fit indices

| | Including all items | Excluding poor items |
|------------|----------------------------------|-----------------------------|
| Chi-square | $X^2(26) = 50.57, p = .003^{**}$ | $X^2(13) = 20.34, p = .087$ |
| CFI | .92 | .96 |
| RMSEA | .07 | .05 |
| SRMR | .06 | .05 |

Note. All fit indices improved with removal of poor items. SIAS = Social Identities and Attitudes scale; CFI = Confirmatory Fit Index; RMSEA = Root Mean Square Error of Approximation; SRMR = Standardized Root Mean Square Residual.

* $p < .05$. ** $p < .01$. *** $p < .001$. All listed p -values are two-tailed.

Table J3.

Factor loadings according to two-factor SOM structure before removing items

| | Standardised factor loadings | se | z | p |
|------|---------------------------------|-------|--------|----------|
| sa43 | 0.600 | 0.050 | 11.903 | <.001*** |
| sa6 | 0.663 | 0.045 | 14.738 | <.001*** |
| sa16 | 0.706 | 0.041 | 17.230 | <.001*** |
| sa21 | 0.570 | 0.053 | 10.800 | <.001*** |
| sa28 | 0.576 | 0.052 | 10.986 | <.001*** |
| sa48 | 0.651 | 0.046 | 14.155 | <.001*** |
| sa55 | 0.483 | 0.059 | 8.163 | <.001*** |

Table J3.
Factor loadings according to two-factor SOM structure before removing items

| | Standardised factor loadings | se | z | p |
|------|---------------------------------|-------|--------|-------------|
| sa60 | 0.516 | 0.057 | 9.065 | <.001*** |
| sa65 | 0.616 | 0.049 | 12.543 | <.001*** |
| sa70 | 0.687 | 0.043 | 16.042 | <.001*** |
| sa1 | 0.643 | 0.047 | 13.762 | <.001*** |
| sa11 | -0.332 | 0.068 | -4.903 | <.001*** |
| sa33 | -0.466 | 0.060 | -7.728 | <.001*** |
| sa38 | -0.424 | 0.063 | -6.734 | <.001*** |
| ma2 | 0.740 | 0.040 | 18.377 | <.001*** |
| ma7 | 0.682 | 0.045 | 14.989 | <.001*** |
| ma12 | 0.645 | 0.049 | 13.256 | <.001*** |
| ma17 | 0.453 | 0.063 | 7.203 | <.001*** |
| ma29 | 0.557 | 0.056 | 10.011 | <.001*** |
| ma34 | 0.488 | 0.061 | 8.053 | <.001*** |
| ma39 | 0.610 | 0.052 | 11.824 | <.001*** |
| ma66 | 0.629 | 0.050 | 12.589 | <.001*** |
| ma22 | 0.351 | 0.068 | 5.131 | <.001*** |
| ma44 | 0.093 | 0.076 | 1.213 | .225 |
| ma49 | 0.254 | 0.073 | 3.497 | <.001*** |
| ma56 | -0.077 | 0.077 | -1.007 | .314 |
| ma61 | 0.298 | 0.071 | 4.208 | <.001*** |
| ma71 | 0.345 | 0.069 | 5.009 | <.001*** |

Note. Issues suggesting poor items are denoted in bold. SOM = Study Orientation in Mathematics. Omega Total = 0.89.

* $p < .05$. ** $p < .01$. *** $p < .001$. All listed p -values are two-tailed.

Table J4.
Factor loadings and communalities before removing items

| | g | Study Attitude | Maths Anxiety | Communalities |
|------|------|-------------------|------------------|---------------|
| sa1 | 0.41 | 0.46 | -0.20 | 0.43 |
| sa6 | 0.36 | 0.56 | | 0.45 |
| sa16 | 0.40 | 0.57 | | 0.49 |
| sa21 | 0.31 | 0.46 | | 0.31 |
| sa28 | 0.35 | 0.46 | | 0.34 |
| sa43 | 0.31 | 0.55 | | 0.41 |
| sa48 | 0.36 | 0.55 | | 0.43 |
| sa55 | 0.20 | 0.52 | 0.20 | 0.35 |
| sa60 | 0.23 | 0.53 | | 0.36 |
| sa65 | 0.36 | 0.48 | | 0.37 |

| | | | | |
|------|-------|--------------|--------------|-------------|
| sa70 | 0.39 | 0.56 | | 0.47 |
| sa11 | -0.30 | | -0.37 | 0.24 |
| sa33 | -0.38 | 0.24 | -0.37 | 0.34 |
| sa38 | -0.37 | 0.20 | -0.40 | 0.34 |
| ma2 | 0.36 | | -0.57 | 0.46 |
| ma7 | 0.36 | | -0.53 | 0.42 |
| ma12 | 0.32 | | -0.52 | 0.37 |
| ma17 | 0.24 | | -0.39 | 0.21 |
| ma22 | 0.20 | | -0.30 | 0.13 |
| ma29 | 0.30 | | -0.48 | 0.33 |
| ma34 | 0.29 | | -0.43 | 0.27 |
| ma39 | 0.29 | | -0.52 | 0.36 |
| ma44 | | | | 0.03 |
| ma49 | | | -0.25 | 0.08 |
| ma56 | | 0.36 | | 0.17 |
| ma61 | | -0.21 | -0.35 | 0.18 |
| ma66 | 0.32 | | -0.56 | 0.41 |
| ma71 | 0.20 | | -0.30 | 0.13 |

Note. Factor loadings less than 0.2 were suppressed.
Issues suggesting poor items are denoted in bold.

Table J5.
Effect of removing items from the SOM on fit indices

| | Including all items | Excluding poor items |
|------------|------------------------------------|-------------------------------------|
| Chi-square | $X^2(349) = 754.5, p < .001^{***}$ | $X^2(188) = 326.09, p < .001^{***}$ |
| CFI | .75 | .89 |
| RMSEA | .08 | .06 |
| SRMR | .10 | .07 |

Note. All fit indices improved with removal of poor items. SOM = Study Orientation in Mathematics; CFI = Confirmatory Fit Index; RMSEA = Root Mean Square Error of Approximation; SRMR = Standardized Root Mean Square Residual.
* $p < .05$. ** $p < .01$. *** $p < .001$. All listed p -values are two-tailed.

Appendix K
Regression Models

Table K.
Regression model summary

| Predictors | <i>Estimates</i> | <i>std. Error</i> | <i>CI</i> | <i>p</i> |
|---|------------------|-------------------|----------------|-----------|
| (Intercept) | 46.82 | 6.18 | 34.71 – 58.93 | <0.001*** |
| Gender | -0.27 | 2.77 | -5.69 – 5.16 | 0.923 |
| Study attitude | 0.83 | 0.34 | 0.17 – 1.50 | 0.014*** |
| Gender consciousness | 0.34 | 0.77 | -1.17 – 1.84 | 0.662 |
| Teacher-student relation | -0.06 | 0.29 | -0.62 – 0.50 | 0.831 |
| Maths anxiety | -22.48 | 6.94 | -36.08 – -8.88 | 0.001*** |
| Gender identity | -0.04 | 0.86 | -1.72 – 1.65 | 0.965 |
| GenderXstudy attitude | -0.09 | 0.39 | -0.86 – 0.67 | 0.815 |
| GenderXgender consciousness | 0.46 | 0.95 | -1.40 – 2.31 | 0.628 |
| Study attitudeXgender consciousness | -0.21 | 0.11 | -0.41 – 0.00 | 0.051 |
| GenderXteacher-student relation | -0.01 | 0.39 | -0.77 – 0.76 | 0.986 |
| Study attitudeXteacher-student relation | 0.03 | 0.02 | -0.01 – 0.07 | 0.138 |
| GenderXmaths anxiety | 14.65 | 9.03 | -3.04 – 32.34 | 0.104 |
| Teacher-student relationXmaths anxiety | -0.39 | 0.55 | -1.47 – 0.69 | 0.479 |
| Study attitudeXmaths anxiety | -0.50 | 0.46 | -1.41 – 0.41 | 0.280 |
| GenderXgender identity | 0.59 | 1.14 | -1.65 – 2.83 | 0.605 |
| Teacher-student relationXgender identity | 0.07 | 0.08 | -0.08 – 0.22 | 0.333 |
| Study attitudeXgender identity | 0.02 | 0.07 | -0.12 – 0.17 | 0.772 |
| Maths anxietyXgender identity | 0.85 | 1.48 | -2.06 – 3.76 | 0.568 |
| Gender consciousnessXteacher-student relation | -0.08 | 0.06 | -0.20 – 0.05 | 0.243 |
| Gender consciousnessXmaths anxiety | -0.19 | 1.30 | -2.73 – 2.34 | 0.881 |
| Gender consciousnessXgender identity | 0.03 | 0.15 | -0.26 – 0.31 | 0.859 |
| GenderXstudy attitudeXgender consciousness | 0.18 | 0.11 | -0.04 – 0.40 | 0.106 |

Random Effects

| | |
|--|-------------|
| σ^2 | 267.88 |
| τ_{00} school | 133.17 |
| ICC | 0.33 |
| N school | 4 |
| Observations | 198 |
| Marginal R ² / Conditional R ² | 0.22 / 0.48 |

Note. Predictor variables are centered and a log transformation was applied to maths anxiety . CI = confidence interval; ICC = intraclass correlation coefficient.

* $p < .05$. ** $p < .01$. *** $p < .001$. All listed p -values are two-tailed.