The influence of gender, parents and background factors on Grade 7 students' beliefs and attitudes towards mathematics in Mozambique

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The third study by the Southern and Eastern Africa Consortium for Monitoring Education Quality (SACMEQ) revealed that achievement in mathematics among Grade 6 children in Mozambique is declining, and gender differences favouring boys persist. This study examined the contribution of parents, economic resources and cultural factors on Grade 7 students' beliefs and attitudes towards mathematics. No gender differences were found, but age, geolocation, number of siblings, education of parent, and possession of economic resources were statistically significant predictors of students' perceived usefulness of mathematics.

Keywords: perceived achievement; perceived usefulness of mathematics; equity in mathematics learning; affective domain; cultural factors

In most developed countries, research on the factors contributing to gender differences in mathematics education have a long tradition, and a variety of explanations for the disparities have been postulated (e.g., Fennema & Peterson, 1985; Leder, 1990). Reyes and Stanic (1988) stated that inequalities in mathematics are reinforced by socioeconomic status, race and gender. The studies by the National Assessment Program on Literacy and Numeracy in Australia (NAPLAN, 2011) show that achievement in mathematics among primary and secondary school students is influenced by parental and background variables. Similar accounts have been reported by the Trends in International Mathematics and Science Studies (TIMSS) among Grade 4 and 8 students (Mullis, Martin & Foy, 2008).

Although gender differences in mathematics achievement have declined in some countries, a recent report from the United Nations shows that Grade 6 girls continue to b disadvantaged in many countries in sub-Saharan Africa (UNESCO, 2012).

Examination of the TIMSS results (Mullis *et al.*, 2008), as well as studies from the Southern and Eastern Africa Consortium for Monitoring Education Quality (SACMEC) (Saito, 2010), show that the magnitude and direction of gender differences in mathematics achievement vary across countries, and are unstable within countries. Hanna (2003) maintained that the fluctuations of gender differences in mathematics achievement indicate that inequalities in mathematics education are more likely to be influenced by socio-cultural contexts than by students' biological characteristics. Hanna (2003) defended this position by observing that in countries with a tradition of supporting mathematics learning for females, gender differences are small. Interestingly, the results from the TIMSS 2007 for Grades 4 and 8 reveal statistically significant gender differences in mathematics performance favouring girls in many Islamic countries (Thomson, Wernert, Underwood & Nicholas, 2008), even though gender equality has not yet been attained in these countries (see UNESCO, 2012).

In Africa, research studies examining the factors that perpetuate gender differences in mathematics achievement are scarce (Asimeng-Boahene, 2006). However, the studies by SACMEQ have provided valuable information about mathematics achievement among Grade 6 students across countries from the sub-Saharan region. For example, the second and the third study revealed that in Kenya, Malawi, Mozambique and Tanzania, boys are performing better than girls in mathematics. Seychelles is the only country from the region where girls performed better than boys in both studies (Saito, 2010). In regard to Mozambique, the SACMEQ studies revealed that boys outperform girls in mathematics and slightly in reading (Saito, 2010). SACMEQ also reported that Mozambique is the country where achievement in mathematics has deteriorated the most over recent years.

Inspired by the SACMEQ results, the current study was conducted in Mozambique with the purpose of examining the influence of parents, socioeconomic status and background factors on Grade 7 students' beliefs and attitudes towards mathematics. Some of the research questions addressed were:

1. Are there gender differences among Grade 7 students' perceived achievement levels in mathematics and other school subjects?
2. Do boys and girls differ with regard to their perceived usefulness of mathematics? Is mathematics viewed by parents as important for their children, and to get a job?
3. Which selected parental background variables best predict students' perceived achievement in mathematics, and perceived usefulness of mathematics?
4. Do students who possess selected economic resources hold more positive views of perceived achievement in mathematics, and perceived usefulness of mathematics than students who do not possess these resources?

Theoretical considerations

The affective domain in mathematics education

McLeod (1992) conceptualised the affective domain in mathematics education as comprising three components: beliefs, attitudes and emotions. DeBellis and Goldin (1999) consider value, interest and aspirations to be part of affect. Mathematics-related beliefs are viewed as the individuals' subjective knowledge: (a) *about mathematics*, (b) *about the self*, (c) *about mathematics teaching*, and (d) *about the social context* where mathematics learning takes place (McLeod, 1992). Else-Quest, Hyde and Hejmadi (2008) related affect with feelings and emotional reactions that students experience during mathematical activities. They indicated that positive emotions (e.g., interest, joy and pride) are associated with better performance, while negative emotions (e.g., anxiety, tension, frustration or panic) yield poor performance in mathematics.

Among other scholars, Grootenboer and Hemmings (2007) and Leder and Forgasz (2010) have focused their studies on another dimension of affect – beliefs and attitudes. Aiken (1980) described an attitude towards mathematics as the predisposition to respond favourably or unfavourably to mathematics tasks. He viewed an attitude as having three attributes: cognition (beliefs, knowledge), affect (emotion, motivation), and performance (behaviour, action).

Beliefs and attitudes were examined in this study because they influence cognitive processes and willingness to engage in mathematical activities (Grootenboer & Hemmings, 2007). Also, the development of positive beliefs and attitudes towards mathematics is a desirable goal of mathematics education in many countries (Mullis *et al*., 2008). In Mozambique, for example, the primary mathematics curriculum stipulates that all children must view mathematics as a useful working tool, and must hold positive beliefs and attitudes towards mathematics learning (Ministério da Educação, 2008).

Notions of perceived achievement in mathematics (PAM), and perceived usefulness of mathematics (PUM) are framed within the affective domain. PUM is defined as "students' beliefs about the usefulness of mathematics currently and in relationship to their future education, vocation, or other activities" (Fennema & Sherman, 1976:5). Luttrell, Callen, Allen, Wood, Deeds and Richard (2010) viewed PUM as incorporating four dimensions: interest, general utility, need for high achievement, and personal cost. Gender differences in PAM and PUM tend to favour boys (Fennema & Sherman, 1976); and perceived competence, prior achievement, and mathematical background also influence PUM (Luttrell *et al*., 2010).

Theoretical framework for the study

Leder's (1990) model of gender differences in mathematics education, and the model of parent socialisation (Eccles, 2005) were used to identify variables of interest to this study. Leder (1990) postulated that gender differences in mathematics learning are influenced by environmental (e.g., society, home and school) and learner-related factors (e.g., belief systems, and differential development of verbal and spatial abilities). Leder's (1990) model was used because it emphasises factors that are modifiable rather than innate characteristics of the learner.

Eccles' (2005:127) model postulated that parents influence their children's achievement related behaviours "through their roles as models, and through their roles as expectancy and value socializers". The model further suggests that children imitate and adopt the behaviours of parents and significant others. That is, if mothers exhibit more mathematics 'avoidance' than fathers, then daughters and sons might develop different mathematics expectancies and subject value. The model stresses the role of parental education on students' educational outcomes. It was thus viewed as having implications for education in Mozambique because the total adult illiteracy rates in 2007 were 39.5% in urban areas, and 79.5% in rural areas (Instituto Nacional de Estatistica, 2011).

Methods

Study site

This study was conducted in five public schools in Sofala Province in Mozambique; the schools represented three regions: urban (3), rural (1) and remote (1). Participants in general spoke one of the following three languages in their homes: *Sena*, *Ndau* and Portuguese; a small percentage of participants spoke other languages. Portuguese is the medium of instruction in Mozambique, and was inherited from the country's Portuguese colonial masters. Ethics approval to conduct this research study in Mozambique was granted by the Monash University Human Research Ethics Committee. Permission to access schools in Sofala Province was obtained from relevant authorities and institutions, and all participants consented to participate in the study.

Recruitment and characteristics of the participants

A convenience sample of 300 Grade 7 students (134 boys and 166 girls) and 225 parents (118 males and 107 females) participated in the study. The average age of the children was 12.9. The districts where the study was conducted were selected by the researcher, but the schools were determined by the Education, Youth and Technology Services.

Instruments: Surveys and interviews

Due to a lack of previous research focused on gender and mathematics education in primary schools in Mozambique, a mixed methods research approach was considered the most appropriate. First, parents and children completed paper-and-pencil surveys at the schools in the presence of the researcher. Assistance was provided, as needed, to assist in reading and understanding the survey items. A month later, ten parents were interviewed to explore further their responses to the survey items.

To examine students' perceived achievement levels, students were asked how good they are in each of nine school subjects taught in primary schools in Mozambique. Each response was reported on a five-point rating scale varying from *weak* (1) to *excellent* (5). For each subject, high scores indicated high perceived achievement level.

To measure students' PUM, 14 items were selected from the *Mathematics Valuing Inventory* (MVI) (Luttrell *et al*., 2010). The items were translated into Portuguese with the authors' permission. To maintain scale reliability, items were back translated into English with the assistance of a person fluent in both languages. An example of an item from the MVI for students was: "There are almost no benefits for me to learn mathematics". The corresponding item for parents was: "There are almost no benefits for my son/daughter to learn mathematics". Responses were reported on five-point Likert-type formats ranging from *strongly disagree* (1) to *strongly agree* (5). To ensure that high scores indicated high PUM, negatively worded items were reverse scored.

To collect data in regard to parental background, cultural factors and possession of economic resources, the students completed a questionnaire asking for school geolocation, home language, number of siblings, number of books, parent education, parent occupation, and whether they have electricity, piped water, a TV, a computer, and the internet in their homes. With respect to personal items, the students were asked whether they possessed calculators, reading and mathematics textbooks, school uniforms, and cell phones.

During the interviews, all parents were asked whether mathematics is important for their children, and whether knowing mathematics helps to get a job. In this article, representative responses to these questions are presented.

Data analysis

The quantitative data were analysed using the Statistical Package for the Social Sciences (SPSS) for Windows (version 20) following Pallant's (2009) guidelines. All categorical variables were coded as 'dummy' variables. The data from quantitative variables measured on equal interval scales were inspected for out-of-range values, plausibility of means, standard deviations, and non-violation of the assumptions of parametric statistical techniques (Tabachnick & Fidell, 2007). Parametric statistical tests were used because they are more robust than the equivalent non-parametric ones when sample sizes surpass 200, and when the data meet the necessary assumptions (Tabachnick & Fidell, 2007). As only ten parents were interviewed, the interview data were analysed manually, following Creswell's (2003) guidelines. First, all interviews were transcribed and each parent's answers were coded. Second, all relevant themes were refined using words that defined them better. To ensure reliability of the codes, the interview transcripts were re-coded three months later.

Results and discussion

T-tests for independent groups were conducted to compare mean scores on perceived achievement for girls and for boys in every subject using a p-value cut-off of .01 (Bonferroni adjustment). A stringent level of statistical significance was used in order to prevent type 1 errors (Pallant, 2009) as several separate tests were performed. Mean scores on perceived achievement, and the results of t-tests for independent groups are presented in Table 1.

Table 1: Means on perceived achievement, results of t-test for independent groups, and results of one-sample t-test by gender (Boys: N = 134; Girls: N = 166)

Subject	**Means**		**Results of t-test for independent groups**	
	Boys	Girls	t	*p*
Physical education	3.76^{**}	3.94^{**}	-	ns
Music education	3.67^{**}	3.87^{**}	-	ns
Portuguese	3.74^{**}	3.69^{**}	-	ns
English	3.59^{**}	3.68^{**}	-	ns
Visual education & technology	3.61^{**}	3.67^{**}	-	ns
Natural sciences	3.44^{**}	3.64^{**}	-	ns
Social sciences	3.31	3.39^{**}	-	ns
Moral & civic education	3.27	3.57^{**}	2.4	<.01
Mathematics	3.17	3.16	-	ns

Response format: 1 = Weak, 2 = Below average, 3 = Average, 4 = Good, 5 = Excellent

**Means are statistically significantly higher than the mean for mathematics at p <.001

As can be seen in Table 1, gender differences in perceived achievement were only found for moral and civic education, and favoured girls. Interestingly, the aim of this subject in Mozambique is teaching children to:

> *Recognize the importance of good behaviour in the family, school, and in the public place, and to respect the rules of personal and public hygiene. To develop love, patriotic spirit, and pride for their country (Ministério da Educação, 2008:348).*

As shown in Table 1, one-sample t-tests were conducted to determine whether mean scores for perceived achievement in mathematics (PAM) for boys (= 3.17) and for girls (= 3.16) differed from the means in other subjects. A Bonferroni adjustment was made to the more rigorous *p*-value of .001 due to the number of t-tests conducted (Pallant, 2009). It is evident that both the girls' and the boys' lowest perceived achievement was in mathematics. Remarkably, both the girls and the boys believed they were best at physical education; the children's highly perceived achievement for physical education is likely to be associated with the nature of the subject. Physical education is an outdoor activity and assessment is generally qualitative.

To explore students' PUM, the sum of the scores on the 14 PUM items was divided by 14 (number of items) to facilitate interpretation of scores within the range 1-5. Then, a t-test for independent groups was conducted to compare boys' and girls' mean PUM scores. However, no statistically significant gender differences were found (girls: M = 3.61, SD = .57; boys: M = 3.71, SD = .53).

Parental and background factors (parent education, parent occupation, geolocation, siblings, and books) were used to examine the variability of PAM and PUM scores individually and in combination. To do so, a standard multiple regression analysis was applied. PUM and PAM scores were entered into the regression equation as dependent variables; parent educational and occupational levels and the other background factors were entered as independent variables. The independent variables that best predicted PUM and PAM as revealed by the standard multiple regression statistics are shown in Table 2.

Table 2: Standard multiple regression statistics and the predictor variables of PUM and PAM scores

Independent variables	**Perceived usefulness of mathematics [PUM]**					**Perceived achievement in mathematics [PAM]**				
	B	SE	β	t	*p*	B	SE	β	t	*p*
Parent education	.05	.02	.20	2.97	<.01	.03	.04	.07	.95	ns
Parent occupation	.01	.03	.01	.18	ns	.13	.07	.13	1.80	ns
Geolocation	.19	.05	.24	3.56	<.001	.14	.11	.09	1.25	ns
Siblings	.13	.04	.19	2.95	<.01	.01	.09	.01	.14	ns
Home language	.06	.06	.06	1.09	ns	.01	.12	.01	.02	ns
Books	.04	.03	.03	1.15	ns	.01	.08	.01	.17	ns

Notes: B = Unstandardised coefficients, SE = Standard error, β = beta coefficient, t = t-test statistics, *p* = significance level, ns = not statistically significant at $p < .05$.

The standard multiple regression analysis revealed that the six independent variables shown in Table 2, as a group, explained 18% of the variance of PUM scores (R^2 =.18), and the result was statistically significant [F(7, 215) = 6.8, $p < .001$]. Although PAM scores were normally distributed and met the basic assumptions related to linearity, homoscedasticity, and independence of residuals (Pallant, 2009), the same group of independent variables explained only 3% of the variance of PAM scores (R^2 =.026), and the result was not statistically significant. This means that 97% of the variance of PAM scores was not explained by the variables examined. Table 2 also indicate that no single variable examined made a statistically significant contribution to the prediction of PAM scores. But, geolocation (β=.24, t = 3.56, p <.001), parent education (β=.24, t = 2.97, p <.01), and the number of siblings (β=.24, t = 2.95, p <.01) predicted PUM scores. After observing that these variables influenced PUM scores, and, as all independent variables had more than two levels, one-way ANOVAs were conducted together with a Tukey or Games-Howell post hoc test to identify which groups differed from each other (Pallant, 2009). It was found that:

- students whose parents had university education had higher mean PUM scores (M = 4.04; SD = 0.56) than the students whose parents had less than Grade 6 (M = 3.46; SD = 0.41; *p* <.01).
- students from urban schools had higher mean PUM scores (M = 3.79; SD = 0.58) than students from rural (M = 3.47; SD = 0.42; *p* <.001) and remote schools (M = 3.39; SD = 0.43; *p* <.001); and
- students with fewer than three siblings had higher mean PUM scores (M = 3.89; SD = 0.56) than those with three or more siblings (M = 3.63; *p* <.01).

One-way between-groups multivariate analyses of variance (MANOVAs) were conducted to determine whether students possessing selected economic resources had higher mean scores on a linear combination of the dependent variables, PAM and PUM, and on the individual variables. The economic resources selected were electricity, piped water, TV, computer, internet, calculator, reading and mathematics textbooks, cell phone, and school uniform. Each resource was entered into the SPSS multivariate equation individually, but the dependent variables were entered as a group. The univariate test results were considered statistically significant at *p* <.025 (Bonferroni adjustment); Wilks' Lambda was preferred over other possible statistics because it is more popular when conducting a multivariate analysis of variance (Pallant, 2009). The results are shown in Table 3.

Table 3: PAM and PUM mean scores, frequencies, multivariate, and univariate test results by selected economic resources (N = 300)

Economic resources	**Dep. var.**	**Possession status Means**				**Multivariate results Wilks' Lambda**				**Univariate results**		
		Yes		No		Val	F	*p*	φ^1	F	*p*	φ^2
Electricity	PAM	208	3.23	90	3.02	.92	13	<.001	.82	2.2	ns	.01
	PUM	208	3.76	90	3.42					25	<.001	.08
Piped water	PAM	148	3.12	150	3.21	.97	3.7	<.01	.03	.50	ns	.01
	PUM	148	3.74	150	3.58					6.6	<.01	.03
Television	PAM	208	3.20	90	3.10	.94	9.7	<.001	.06	.48	ns	.01
	PUM	208	3.75	90	3.45					19	<.001	.06
Computer	PAM	60	3.22	238	3.16	.95	7.8	<.001	.05	.14	ns	.01
	PUM	60	3.90	238	3.60					16	<.001	.05
Internet	PAM	33	3.52	265	3.13	.96	6.3	<.01	.04	3.6	ns	.01
	PUM	33	3.93	265	3.62					9.7	<.01	.03
Calculator	PAM	89	3.34	209	3.09	.99	1.5	ns	.01	2.9	ns	.01
	PUM	89	3.66	209	3.65					.02	ns	.01
Cell phone	PAM	114	3.25	184	3.11	.99	1.3	ns	.01	1.1	ns	.01
	PUM	114	3.61	184	3.69					1.3	ns	.01
Reading	PAM	223	3.18	75	3.15	.99	.14	ns	.01	.04	ns	.01
textbook	PUM	223	3.67	75	3.63					.25	ns	.01
Mathematics	PAM	224	3.19	74	3.14	.99	.32	ns	.01	.08	ns	.01
textbook	PUM	224	3.67	74	3.61					.59	ns	.01
School	PAM	271	3.18	27	3.07	.98	2.1	ns	.01	.21	ns	.01
uniform	PUM	271	3.68	27	3.45					4.1	ns	.01

Notes. Response formats: Economic resources (independent variables): Yes, No; PAM: 1 = Weak, 2 = Below average, 3 = Average, 4 = Good, 5 = Excellent; PUM: 1 = Disagree strongly, 2 = Disagree, 3 = Unsure, 4 = Agree, 5 = Agree strongly; φ^1: The proportion of variance on combined dependent variables explained by the independent variable; φ^2: The proportion of variance on individual dependent variables explained by the independent variable; Val = Wilks' Lambda statistics.

As can be seen in Table 3, there were statistically significant differences in the mean scores on the linear combination of PAM and PUM scores for children having electricity, piped water, TV, computer, and the internet in their homes when compared to students without these resources. A follow-up analysis of the estimated marginal means (Pallant, 2009) showed that the children possessing these resources had higher mean scores than the students who did not. However, when the results of the dependent variables were considered separately it was noted that only PUM was influenced by resources. Table 3 also shows that possession of calculators, cell phones, school uniforms, and reading and mathematics textbooks did not influence PUM scores. In Mozambique, there are some possible explanations for this. Calculators are not part of the official mathematics curriculum, so they may not be perceived as useful. Textbooks are offered to children by the government. Thus, to have a textbook does not necessarily indicate the level of socioeconomic status of the child. About 40% of the students reported having a cell phone. As most questions on the survey asked about items that the child had at home, it is possible that some children declared the possession of a family cell phone, whether or not it was used by or belonged to the child.

This study also explored whether parents viewed mathematics as important for their children and for getting jobs. All parents interviewed believed mathematics was important for their children, but the majority believed mathematics did not help to get jobs. The responses of all parents interviewed were examined and representative ones are presented below. For example, parents indicated that mathematics was important for their children because "it opens capacity and improves reasoning" (Father); "it helps to make calculations, for example, to check whether the money you were paid out by your employer corresponds to the number of days you worked" (Mother); "mathematics is intelligence. If you know mathematics you can do anything you like. You can do physics, chemistry, or geography. Mathematics is the foundation of everything. Carpenters, shoemakers, or builders rely on mathematics" (Father); and "it is through mathematics that we can carry out calculations, and perform some services" (Mother). During the interviews parents frequently used words such as 'reasoning', 'memory', 'calculations', 'counting', 'salary', 'money', and 'change'.

Only three parents believed mathematics helps to get a job. They argued that "people who understand mathematics can work in big industries, laboratories and plants. In these jobs, advanced mathematics is used, precision is required, and no mistakes are allowed" (Father); "any employment uses mathematics" (Father); and "companies like people who are good at mathematics" (Mother). Seven parents believed mathematics was not important to get jobs, but only three clearly articulated reasons, saying that "advertisements for jobs never talk about mathematics, they talk about fluency in English – written and spoken, and computer skills" (Father); "mathematics alone does not help to get a job. The person must be good in all subjects" (Mother); "not these days. In the past, I would agree that to know mathematics helped to get a job. These days jobs are for friends and not for the right people" (Father).

Conclusions, limitations of the study and recommendations

The data from this study revealed no gender differences in students' perceived usefulness of mathematics (PUM) or perceived achievement in mathematics (PAM). Gender differences were noted only for perceived achievement level in moral and civic education, and the difference was in favour of girls. Both girls and boys believed mathematics was their worst subject and physical education their best. However, geolocation (urban), parent education (university), number of siblings (fewer than three), and having electricity, piped water, a TV, a computer, and the internet at home were related to higher level of PUM, but not PAM. Furthermore, parents believed mathematics is important for their children, but the majority did not associate mathematics with jobs.

The results of this study did not challenge previous research findings with respect to the influence of economic resources, parental education, and other background variables on mathematics learning outcomes (e.g., Grootenboer & Hemmings, 2007; Mullis *et al*., 2008; NAPLAN, 2011). The findings did reveal, however, that parental education, number of siblings, and possession of selected economic resources are the best predictors of PUM among Grade 7 children in Sofala, Mozambique. None of the variables examined predicted PAM in a statistically significant way; this calls for further research to identify factors that may explain the variance of PAM scores.

To ensure equity in educational outcomes, the findings from this study have implications for government policy and mathematics teaching in Mozambican primary schools. The data also revealed that parents only associate mathematics with low level use such as counting, calculating, and developing reasoning skills. Strikingly, the majority of parents did not know how mathematics is related to jobs.

The results from this study are concerning because mathematics is a gateway to accessing higher education and to rewarding jobs (Leder, Pehkonen & Töner, 2002). If children view mathematics as the most difficult subject, and if their parents associate mathematics only with low-level use and do not relate mathematical knowledge with jobs, the country will have difficulties competing with others in the global and the technological world of the 21st century.

One limitation of this study was that it was conducted only in one province, Sofala, in Mozambique. Thus, to increase understanding of the cultural factors influencing children's PAM and PUM it would be important to replicate the study in other provinces and to examine more independent variables. Some children and parents in this study had difficulty reading the Likert-type items. Until the issue of illiteracy is overcome in Mozambique, future studies should also include interviews, particularly in rural areas.

With the recent discoveries of large reserves of oil, gas and mineral resources in Mozambique, children and parents need to more fully appreciate the importance and relevance of mathematics, science and technology in order to seize opportunities and increase the likelihood of being able to work in these sectors. If they do not, Mozambique will continue depending on foreign skilled workers while the majority of nationals have no jobs.

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