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Perceptions of Teaching Approach and Academic Performance among Senior Two Students in Musanze: Mediating Role of Mathematics Anxiety and Career Aspiration

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Abstract. This empirical study sought to examine gender differences and the relationships between students' perceptions of mathematics teaching, mathematics anxiety, career aspirations, and academic performance. The study utilized the descriptive-correlational research design coupled with the quantitative data collection process, i.e., a survey questionnaire. We deliberately sampled six lower secondary schools in Musanze district to participate in the study. A total of 415 (60 % males) senior two students (grade 8) were involved in the study. Data were analyzed using an independent sample t-test and structural equation modeling. Students' perceptions of the teaching approach significantly influenced career aspirations, mathematics anxiety, and performances. In addition, mathematics anxiety affected the relationship between students' perceptions of the teaching approach and performance and career aspirations. Although girls' mathematics anxiety, mathematics performance, and perceptions of the teaching approach were higher than boys', the differences were not statistically significant. The findings of this study revealed that students' perceptions of the teaching approach influence their mathematics performance, mathematics anxiety, and career aspirations. Therefore, any intervention aimed at reducing mathematics anxiety and improving academic performance and career aspirations in Mathematics should consider students' perceptions of the teaching approach.

Keywords: career aspiration; mathematics anxiety; structural equation modeling; students' perception; teaching approach

1. Introduction

Developing mathematical skills is crucial for academic success and career choices in Science, Technology, Engineering, and Mathematics (STEM) since those fields rely on it (Rozgonjuk et al., 2020). STEM education is being realized as the foundation of any modern society's development and wellbeing because it stimulates innovation and creates workers who can drive and respond to technological advancements (Croak, 2018); therefore, it has become an integral part of countries' economic and social development plans (Bybee, 2013). Despite Rwanda's substantial efforts to promote STEM education over decades, Mathematics is still the worst-performing subject in the national examination at the lower secondary school level compared to science subjects, with more than 70 percent of the candidates scoring below the pass mark (Rwanda Education Board, 2016). Looking at the Rwanda Education Board statistics of previous lower secondary national examinations, only a very small percentage of all candidates (21.5% of 100,640 candidates in 2018; 19.3% of 99,000 candidates in 2019; and 29.5% of 100,263 candidates in 2020) passed in Mathematics. In addition, few students pursue mathematics-related courses at secondary and tertiary levels, and females are particularly underrepresented in STEM education (Huggins & Randell, 2007; Masanja, 2010). Despite a comparatively equal number of girls and boys in classrooms, Menon (2021) reported boys outperforming girls in 26 of Rwanda's 30 districts. A study conducted by Uwineza et al. (2018) has shown that teachers' teaching approaches are one of the factors contributing to low performance among girls. The study found that teachers' teaching approaches were more boy-oriented than girl-oriented, and more boys than girls study Mathematics to obtain a good job or to become mathematicians. Taking into consideration students' perceptions of the teacher's teaching approach could improve our understanding of gender differences in mathematics performance and the relationship between students' performance and the teacher's teaching approach. However, to the best of our knowledge, none of the study in Rwanda has studied influence of students' perceptions of teaching approach on their mathematics performance.

Having good mathematics performance is one of the prerequisites for admission to most STEM fields in Rwanda. Rwanda's education system places a high value on Mathematics, as evidenced by the high number of hours dedicated to the subject (compared to other subjects) and its mandatory status of nine schooling years (primary and lower secondary schools). The schooling system in Rwanda includes six years of primary education, three years of lower secondary education, and three years of upper secondary education (6+3+3). Upper secondary students specialize in a combination of three principal subjects depending on their interests. Nevertheless, subsidiary mathematics is mandatory for students who do not take Mathematics as one of their principal subjects but have at least one principal subject that requires some mathematical knowledge.

The poor performance in Mathematics has been attributed to high levels of mathematics anxiety; failure to connect Mathematics with students' future careers; and others (Cargnelutti et al., 2017; Henschel & Roick, 2017; Richland et al., 2020; Szczygieł, 2021; Uwineza et al., 2018). There have been several studies that examined the relationship between students' performance and psychological factors, such as career motivation and mathematics anxiety (Cargnelutti et al., 2017; Henschel & Roick, 2017), but none has been conducted in Rwanda. An understanding of this relationship would contribute to Rwanda' success in meeting its development goals of prioritizing STEM education and improving mathematics literacy among its citizens. While other studies have studied some of the variables of interest, they did not include all the variables being considered in the current study. Therefore, to deepen teachers' understanding of these variables for better mathematics teaching, the present study examined the interrelationships between senior two students' mathematics anxiety, career aspirations, mathematics performance, and their perceptions of the teaching approach. In addition, gender differences across these study constructs were examined.

2. Literature Review

2.1. The Relationship between Perceptions of Teaching Approach and Mathematics Anxiety

Ramirez et al. (2018) defined mathematics anxiety as a negative emotional reaction experienced when people are exposed to mathematics learning or mathematical problems. Studies have examined the relation between mathematics anxiety and mathematics instructional practices (O'Leary et al., 2017). According to the findings of those studies, students who showed good perceptions of their teacher's teaching approach had less mathematics anxiety. By asking students to rate how they perceive their teacher's teaching approach, Bekdemir (2010), found that the teacher's teaching approach contributes to students' mathematics anxiety. Based on the previous studies, we hypothesized that students with negative perceptions of the teaching approach experience more mathematics anxiety than students with positive perceptions.

2.2. The Relationship between Mathematics Anxiety and Mathematics Performance

Hembree's (1990) meta-analysis reported an average correlation of -0.31 and -0.34 between achievement and anxiety for college and school students, respectively, indicating that mathematics anxiety significantly hinders mathematics performance. Hembree also found that the relationship between mathematics anxiety and performance changes with grade levels peaks during junior to high school years. Although many studies indicate that mathematics anxiety and achievement are negatively related (Hembree, 1990; Meece et al., 1990; Richland et al., 2020; Szczygieł, 2021), the direction of this relationship is still unclear (Carey et al., 2016; Foley et al., 2017). The literature suggests that: (i) mathematics anxiety contributes to poor mathematics performance (Richland et al., 2020; Szczygieł, 2021), (ii) poor mathematics performance contributes to mathematics anxiety (Alkan, 2018). Accordingly, the current study hypothesized a bidirectional relationship between mathematics anxiety and mathematics performance.

2.3. The Relationship among Mathematics Anxiety and Career Aspirations

Mathematics anxiety has been linked to negative attitudes about mathematics in which students avoid mathematics problems or tasks, resulting in poor achievement (Buckley et al., 2016; Dowker et al., 2016) and careers involving mathematics avoidance (Ashcraft, 2002; Chipman et al., 1992). For instance, Chipman et al. (1992) found that mathematics anxiety and scientific career intentions are negatively correlated. However, Meece et al. (1990) found no significant direct effects of mathematics anxiety on young adolescents' course enrolment intentions. It was noted in Huang et al. (2019) that mathematics anxiety directly influenced career interest among girls, but not among boys. According to these inconsistent findings, this relationship seems to be context dependent. In our study, we examined this relationship by testing the hypothesis that students with higher levels of mathematics anxiety would avoid careers that involve Mathematics.

2.4. The Relationship between Mathematics Performance and Career Aspirations

According to Nyacomba (2017), there is a positive correlation between mathematics achievement and career aspirations. According to him, students who aspired to study a course that would involve mathematics (e.g., medicine or engineering) were more likely to perform better in Mathematics. A study carried by Chen et al. (2015) indicated that students are intrinsically motivated to score good grades to be qualified for choosing a career they desire. According to Shapka et al.'s (2006) longitudinal study, mathematics achievement acts as a "critical filter" to career aspirations, with poor mathematics performers aspiring to less prestigious careers. One could argue that it is hard for someone who has never passed Mathematics to aspire to pursue a career that requires mathematical knowledge. In this regard, we hypothesized a bidirectional relationship between mathematics performance and career aspirations.

2.5. The Relationships among Perceptions of Teaching Approach, Career Aspirations, Mathematics Anxiety, and Performance

Negative attitudes towards teachers' teaching approach negatively affect students' interest and academic performance in Mathematics (Mutodi & Ngirande, 2014), making students to avoid Mathematics. Oden (2021) reported that students who recognize that their teacher often applies mathematical content to daily-life situations are more interested in Mathematics and showed good performance. Despite the lack of studies that include all four constructs (perceptions of teaching approach, mathematics anxiety, career aspirations, mathematics performance) to investigate the link between them, we hypothesized that students with positive perceptions of the teaching approach are more likely to feel less mathematics anxiety, to perform well in Mathematics, and to choose careers that require mathematical knowledge.

2.6. Conceptual Framework

According to Baloglu and Kocak (2006), mathematics anxiety could originate from situational, dispositional, and environmental factors. The present study considers mathematics anxiety caused by environmental factors that include individual's experiences in mathematics class and perceptions of teaching approach

(Newstead, 1995; Tobias, 1990). Based on the literature, one can argue that teachers' mathematics teaching approach creates a learning environment that can impact students' mathematics anxiety and pave the way for students' academic success and aspiring future career choices. In the present study, students' perceptions of the teacher's teaching approach could be conceptualized as environmental factors influencing mathematics anxiety, career aspirations, and academic performance. Some researchers believe that mathematics anxiety has two key negative consequences: mathematics avoidance and poor performance (Daker et al., 2021; Ramirez et al., 2018; Szczygieł, 2021). Previous research has found that mathematics anxiety affects students' career aspirations and mathematics achievement. Previous studies indicate that mathematics performance is influenced by (a) perceptions of teaching approach, (b) career aspirations, and (c) feelings of anxiety towards Mathematics. However, some studies indicate that mathematics performance impacts career aspirations and mathematics anxiety. Accordingly, we predicted a bidirectional relationship between mathematics achievement and mathematics anxiety, and mathematics performance and career aspirations, as illustrated in Figure 1.

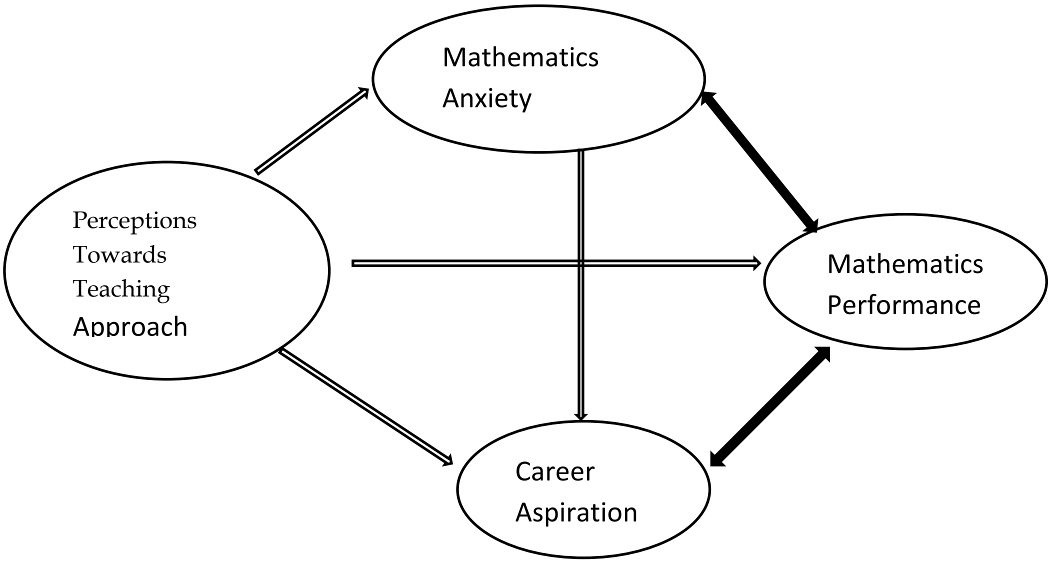

Figure 1: Conceptual model representing structural relationships among research variables

2.7 Present Study

The purpose of this research is to find out the gender differences between study variables and the mediating roles of mathematics anxiety and career aspirations into the relationship between students' perceptions towards mathematics teaching approach and mathematics performance. Although the previous studies investigated the relationships between mathematics anxiety and mathematics performance, to the best of our knowledge, this is the first study to consider students' perceptions of mathematics teaching approach and their career aspirations in understanding the influence of mathematics teaching methods on mathematics performance among senior two students. This study has two main objectives: (a) to examine gender differences in mathematics anxiety, career aspirations, mathematics performance, and teaching approach perceptions; (b) to examine the mediation effect of mathematics anxiety and career aspirations on the relationship between teaching approach perceptions and mathematics performance.

3. Methods

3.1. Research Design

This study examined the relationship amongst four main constructs: students' perceptions of teaching approach, mathematics anxiety, career aspirations, and mathematics performance using a descriptive-correlational research design. This design allows a researcher to describe study variables and examine their relationship rather than focusing on their cause and effect (Williams, 2007).

3.2. Population and Sampling

For this study, the target population was senior two (S2) students from secondary schools in Musanze District, with a total of about 1,480 senior two students. This region in the Northern Highlands of Rwanda was chosen because students' performance in Mathematics during lower secondary national exams from 2015 to 2020 was poor (Rwanda Education Board, 2016). In that district, eight (8) secondary schools with large numbers of failures in Mathematics in lower secondary national exams were selected. Two schools participated in the pilot study while the rest participated in the main study. We deliberately chose senior two students due to their sufficient experience in secondary school life and the fact that they were not overburdened with preparing for national examinations. Each of the selected schools had two classes of senior two with approximately 45 students per class and all students were allowed to participate in the study. A total of 415 students (ranging in age from 12 to 18 years (mean = 14.8, st. dev = 1.1)) participated in the data collection process and filled out the consent form. The sample comprised more males (n=248, 60%) than females.

3.3. Procedures

Prior to this study, ethic clearance was obtained. The authorization for data collection was issued by the District Education Officials (DEO) of Musanze, in Rwanda. After obtaining the data collection authorization, the Principal Researcher visited all sampled schools and met the administrators to elicit their support. The purpose and objectives of the study were explained to senior two students, and there was also an adequate time for questions. Afterward, a pilot study was conducted in two schools (among 8 schools selected) where students individually filled out a printed survey. The results of a pilot study suggested the revision of some items of the survey for alternative wording that would be easier to understand. After revising the survey's items, the Principal Researcher administered a revised survey in 6 schools (among 8 schools selected) that did not participate in a pilot study. Individually, students responded to the survey between 15 to 30 minutes. The data gathered were analysed and interpreted in relation to the research objectives.

3.4. Measures

We used a survey questionnaire and mathematics exam results as data collection tools. A survey consisted of students' perceptions of teaching approach (SPTA), mathematics anxiety (MA), career aspirations (CA) constructs. Likert scale scores ranged from (1) strongly disagree to (5) strongly agree.

3.4.1. Career Aspirations

The current study adapted items from the career motivation subscale of the Science Motivation Questionnaire II (SMQ-II; Glynn et al., 2011) to measure lower secondary students' career aspirations for mathematics, replacing the word "science" with "mathematics." Sample items include: "My career will involve mathematics", and "Knowing mathematics will give me a job advantage" The internal consistency (the Cronbach's alpha) for the career aspirations construct is 0.76.

3.4.2. Mathematics Anxiety

Students' mathematics anxiety was assessed through five items adapted from the Science Motivation Questionnaire (Glynn & Koballa, 2006). Some of the items adapted include "I hate taking the mathematics tests", and "I become anxious when it is time a mathematics test". The mathematics anxiety scale used in this study had an acceptable reliability coefficient (α=0.78).

3.4.3. Perceptions of Teaching Approach

We assessed perceptions of students towards teacher's teaching approach using six items adapted from the Mathematics Lessons sub-scale of the 2015 Trends in International Mathematics and Science Study (TIMSS) student questionnaire for 8th graders (Trends in International Mathematics and Science Study, 2015). The students rated their feelings about the teacher's teaching approach on a 5-point scale (1 = strongly disagree to 5 = strongly agree). The sample item includes "The way my teacher teaches mathematics makes me love it." The internal consistency of the measure was good, as demonstrated by Cronbach's alpha, α= 0.82.

3.4.4. Mathematics Performance

This study used students' mathematics exam results to measure their mathematics performance. Country-wide, students do mathematics exams at the end of each term and the questions are set up by a team of experts who developed the national curriculum together with a group of secondary school teachers.

3.5. Data Analysis

We first computed descriptive statistics and estimated inter-correlations between study constructs. Afterward, using an independent sample t-test, we tested gender differences among measured variables. To examine the mediation effects of mathematics anxiety and career aspirations on the relationship between perceptions of teaching approach on mathematics performance, we used a structural modelling equation (SEM). Before conducting an SEM analysis, we screened data for multivariate normality, homoscedasticity, outliers, multicollinearity, sample size requirements, and missing values, as suggested by Civelek (2018). Although the data were not normally distributed, Hawkins (1981)'s test of homoscedasticity and multivariate normality revealed equal variance. No outliers or missing values were found in the data, and multicollinearity was not detected. Based on Monte Carlo simulation some authors (Wolf et al. (2013)) suggested sample sizes ranging from 30 to 460 cases for SEM analysis, depending on factors and indicators, loadings and path coefficients, and missing data, which was undoubtedly met by our sample size of 415. Kline (2015) recommended a minimum of 100 observations to estimate SEM, while 200 observations are required for reliable estimates.

Since no priori model combines the study variables in a single model, a measurement model was tested by first analysing the correlation test between the factors, followed by confirmatory factor analysis (CFA). Using a chi-square difference test ($\Delta\chi^2$) and model fit indices (Comparative Fit Index (CFI > 0.90), Tucker-Lewis Index (TLI > 0.90), Root Mean Square Error Approximation (RMSEA ≤ 0.06) and Standardized Root Mean Square Residual (SRMR ≤ 0.08)) suggested by Hu and Bentler (1999), we tested and compared four hypothesized models (see Figure 2) to determine which would best describe the data. Using a finalized model, we estimated the direct and indirect effects of perceptions of teaching on mathematics performance. Test of joint significance approach (Leth-Steensen & Gallitto, 2015) was used to test the significance of the total indirect effect of perceptions of teaching approach on mathematics performance and specific indirect effects. As Graham and Coffman (2012) recommended for non-normal data, the maximum likelihood estimator with robust standard errors (MLR) was used in the analysis. The present study used R statistical software (R Core Team, 2019) for data analysis.

4. Results

4.1. Preliminary Results

The correlation matrix (see Table 1) shows that all the variables are significantly correlated. The students' perceptions of the teaching approach positively correlate with career aspirations and mathematics performance but negatively correlate with mathematics anxiety. Mathematics anxiety is negatively correlated with career aspiration and mathematics performance, indicating that higher mathematics anxiety is associated with lower levels of mathematics performance and career aspiration.

Table 1: Correlation matrix of the study variables

Variables	SPTTA	CA	MA	MP
SPTTA	1.00			
CA	0.77**	1.00		
MA	-0.60**	-0.59**	1.00	
MP	0.49**	0.46**	-0.63**	1.00
Mean	2.19	2.28	3.68	2.35
Standard Deviation (SD)	0.05	0.21	0.15	1.03

** $p < 0.01$

Before conducting gender differences comparison, we first tested measurement invariance of the research instrument to know whether boys and girls interpreted the questionnaire's items similarly. The results confirmed the measurement invariance (see Table 2 in Appendix); a mean comparison by gender could be conducted next. Despite females scoring higher in mathematics anxiety, mathematics performance, and perception of the teaching approach, the difference was not statistically significant (see Table 3).

4.2. Reliability and Validity

The validity and reliability of an instrument are essential for SEM analysis; therefore, we used the average variance extracted (AVE), the Cronbach Alpha (α), and composite reliability (CR) measures to determine reliability and validity. Table 4 (see in Appendix) indicates that AVEs are greater than 0.5 (the value suggested by Kline (2015)), factor loadings (FL), composite reliability, and Cronbach's Alpha values exceed 0.7 (the value suggested by Hu and Bentler (1999); Wang and Wang (2019)), indicating acceptable reliability and validity of the research instrument.

Table 3: T-statistics for gender differences among the constructs

Constructs	Gender	Means	SD	Test	P-value
SPTTA	Male	2.18	0.73	-0.24	0.80
	Female	2.20	0.81		
CA	Male	2.30	0.73	0.66	0.50
	Female	2.25	0.77		
MA	Male	3.65	0.92	-0.98	0.32
	Female	3.73	0.70		
MP	Male	2.34	1.09	-0.06	0.95
	Female	2.35	0.94		

4.3. Model Testing and Comparison

The first model (see Figure 2) was tested, and all the fit indices ($\text{CFI} = 0.975;\ \text{TLI} = 0.972;\ \text{RMSEA} = 0.035;\ \text{SRMR} = 0.032$) were above the acceptable values, and all factor loadings were significantly higher than 0.4, as Matsunaga, (2010) recommended. However, the results showed that students' career aspirations had no significant relationship to their mathematics performance (standardized coefficient=0.045, p=0.585). A chi-square difference test was then used to compare model 1 and the model without directly influencing career aspirations on mathematics performance (model 2). The chi-square difference test found no significant difference ($\chi^2 = 10.649, df = 1, p = 0.310$) between the two models (model 1 and model 2), indicating that both models fit the data equally well. Model 2 ($\text{CFI} = 0.977;\ \text{TLI} = 0.973;\ \text{RMSEA} = 0.034;\ \text{SRMR} = 0.031$) was chosen over model 1 for parsimony reasons. Following Shapka et al.' s (2006) findings that mathematics performance acts as a " critical filter" to career aspirations, model 3 with a hypothesized path from mathematics performance to career aspirations was considered, and the model was compared to model 2. The added path did not show statistical significance (standardized coefficient=0.005, p=0.085). Again, based on the chi-square difference test ($\chi^2 = 14.920, df = 1, p = 0.640$) between the two models (model 2 and model 3), we chose model 2 over model 3 ($\text{CFI} = 0.974$; $\text{TLI} = 0.971$; $\text{RMSEA} = 0.036$; $\text{SRMR} = 0.042$) for parsimony reasons. The influence of mathematics performance on mathematics anxiety suggested by Alkan (2018) was tested in model 4. However, the path $MP \rightarrow MA$ was not statistically significant (standardized coefficient=-0.0232, p=0.008). The chi-square difference test ($\chi^2 = 12.096, df = 1, p = 0.460$) between the two models (model 2 and model 4) supported that both models fitted the data equally well, but we chose model 2 over model 4 ($\text{CFI} = 0.976$; $\text{TLI} = 0.971$; $\text{RMSEA} = 0.036$; $\text{SRMR} = 0.052$) for parsimony reasons.

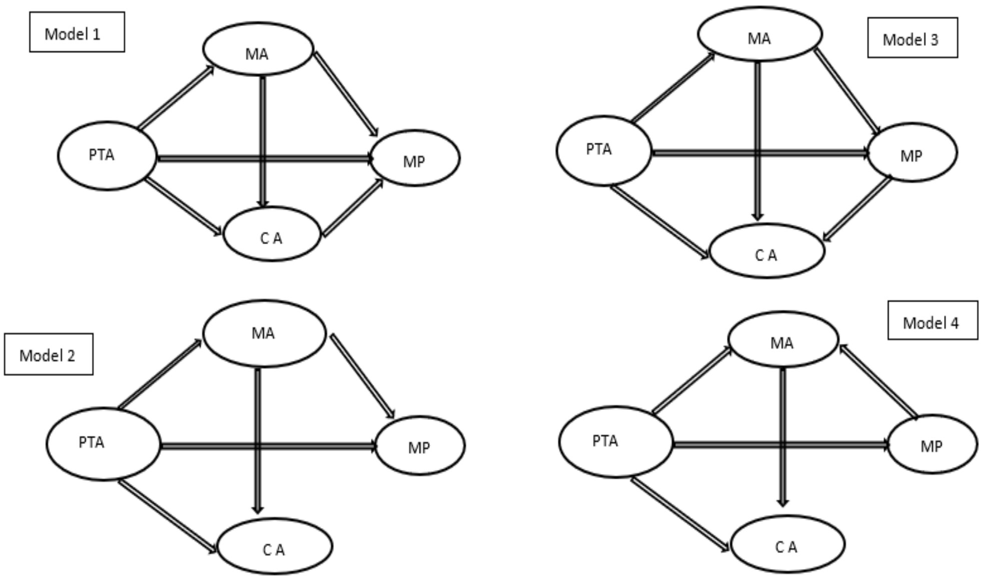

Figure 2: Hypothesized models in the study

4.4. Mediation Effects of Mathematics Anxiety and Career Aspirations

As hypothesized (see Figure 2 and Figure 3), students' perceptions of the teaching approach negatively contributed to mathematics anxiety ($\beta_{PTA \rightarrow MA} = -0.664, SE = 0.039, p = 0.000$) and positively to career aspiration and mathematics performance ($\beta_{PTA \rightarrow CA} = 0.641, SE = 0.037, p = 0.000$; $\beta_{PTA \rightarrow MP} = 0.217, SE = 0.080, p = 0.0007\ respectively$). Additionally, students' mathematics anxiety significantly and negatively predicted their mathematics performance ($\beta_{MA \rightarrow MP} = -0.633, SE = 0.024, p = 0.000$) and career aspirations ($\beta_{MA \rightarrow CA} = -0.177, SE = 0.036, p = 0.000$). Indirectly students' perceptions of the teaching approach significantly contributed to mathematics performance and career aspiration via mathematics anxiety ($\beta_{PTA \rightarrow MA \rightarrow MP} = 0.420, SE = 0.059, p = 0.000$, $\beta_{PTA \rightarrow MA \rightarrow CA} = 0.117, SE = 0.024, p = 0.000\ respectively$). The results above imply that mathematics anxiety partially mediated the relationship between students' perceptions of teaching approach and mathematics performance and the relationship between students' perceptions of teaching approach and career aspirations. However, career aspirations did not mediate the relationship between students' perceptions of teaching approach and mathematics performance. The total effect of students' perceptions of teaching approach on mathematics performance and career aspiration was positively and statistically significant ($\beta_{PTA \rightarrow MA} = 0.667, SE = 0.055, p = 0.000$; $\beta_{PTA \rightarrow CA} = 0.759, SE = 0.030, p = 0.000$, respectively).

Table 5: Indirect/mediation effects of study variables

Direct effect				
	Standardized estimates	SE	p-value	Remark
PTA ⟶ CA	0.641**	0.037	0.000	Supported
PTA ⟶ MA	-0.664**	0.039	0.000	Supported
PTA ⟶ MP	0.217**	0.080	0.0007	Supported
MA ⟶ CA	-0.177**	0.036	0.000	Supported
MA ⟶ MP	-0.633**	0.024	0.000	Supported
MP ⟶ MA	-0.0232	0.043	0.080	Not supported
CA ⟶ MP	0.045	0.083	0.585	Not supported
MP ⟶ CA	0.005	0.048	0.085	Not supported
Indirect/mediation effect				
PTA ⟶ CA ⟶ MP	0.029	0.054	0.589	No mediation
PTA ⟶ MA ⟶ MP	0.420**	0.059	0.000	Partial mediation
PTA ⟶ MA ⟶ CA	0.117**	0.024	0.000	Partial mediation
Total effect of PTA on MP	0.667**	0.055	0.000	
Total effect of PTA on CA	0.759**	0.030	0.000	
			** $p < 0.001$	

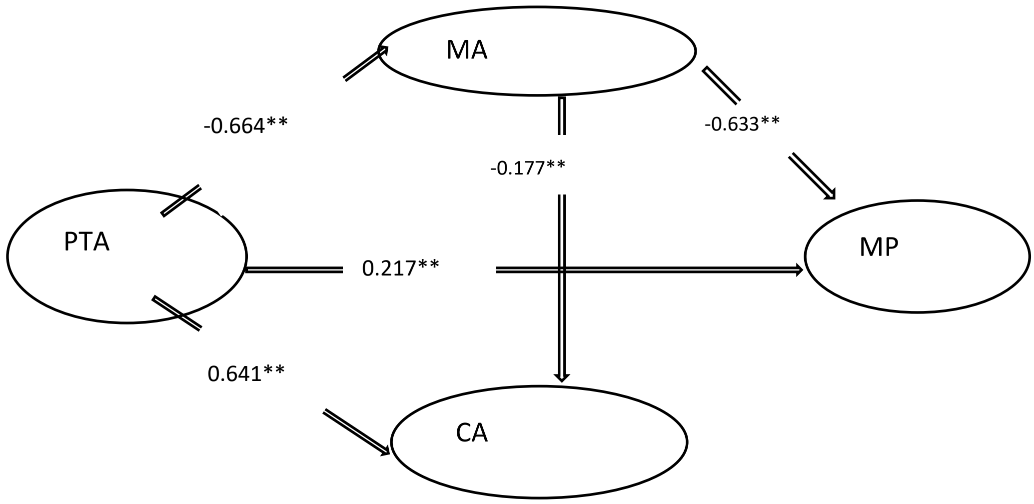

Figure 3: Estimated structural model after excluding non-significant paths (model 2)

5. Discussion

The findings of this study revealed that students' perceptions of the teaching approach positively correlate with career aspirations and mathematics performance but negative correlate with mathematics anxiety. Students who reported positive perceptions of their teachers' mathematics teaching were more likely to feel less anxious about the subject and were more likely to pursue mathematics-related careers, resulting in a good performance. Our results concerning a negative association between students' perceptions of teaching approach and mathematics anxiety was consistent with the findings of O'Leary et al.'s (2017) study which found that students who had good perceptions of their teachers' teaching approach had lower mathematics anxiety. Mathematics anxiety also negatively correlated with career aspiration and mathematics performance, indicating that highly mathematics anxious students perform poorly in mathematics and thought that they will not need Mathematics in their future career. Consistent with Hembree (1990) findings, mathematics anxiety was related to poor performance in Mathematics. However, poor mathematics performance was not related to mathematics anxiety. Hembree's (1990) meta-analysis revealed that mathematics anxious students avoid mathematics-related situations, suggesting that mathematics anxiety impedes learning opportunities and thus negatively affects academic performance. Buckley et al. (2016) and Dowker et al. (2016) linked mathematics anxiety to poor performance whereas Ashcraft (2002) and Chipman et al. (1992) associated it with mathematics-related careers avoidance. Our study revealed how students perceive their teachers' teaching approaches significantly influences their mathematics performance and career aspirations via mathematics anxiety. It is expected that students who perceive that their teachers teach well will have less mathematics anxiety (O'Leary et al., 2017), which will lead them to do well in mathematics and be willing to pursue careers in mathematics.

Even though Menon (2021) and Uwineza et al. (2018) found that females are less likely to do well in mathematics and to pursue mathematics-related careers, the present study revealed that female students in Rwanda perform equally well in mathematics and are similarly motivated to pursue mathematics-related careers as their male counterparts. Contrary to Hembree (1990), who found higher mathematics anxiety levels among females than males, there were no gender differences in students' mathematics anxiety.

6. Implications of Findings

The present study demonstrated that students' perceptions of teaching approach predict mathematics performance and explain differences in career aspirations and mathematics anxiety among senior two students. Findings on senior two students' perceptions may inform pedagogical decisions in improving their mathematics performance. Considering the recent reform from a knowledge-based curriculum to a competence-based curriculum in Rwanda, our research findings suggest that students' perceptions of teaching approach should be considered while implementing any intervention to improve their performances, career aspirations, and to reduce anxiety in Mathematics. As done at the university level in Rwanda, secondary teachers should also give a time for students to evaluate their teaching approaches and let them suggest what can be improved. This would help teachers to know what students think about their teaching approaches, hence adjust their teaching according to students' needs.

7. Limitations

The present study used cross-sectional data; hence, this study cannot infer causal relationships due to cross-sectional data. In addition a self-reported questionnaire, which is prone to social desirability (Creswell & Clark, 2017) was used. Therefore, quantitative results should be complemented by qualitative results in future research to validate and enrich the study results. As our study was limited to senior two students from six low-performing schools in Musanze District, the results cannot be generalized. In the absence of longitudinal data, it is impossible to construct a definite model showing whether the relationships observed in this study are stable over time. Thus, we recommend that longitudinal studies be conducted on the relationship among perceptions of teaching approach, career aspirations, mathematics anxiety, and mathematics performance.

8. Conclusion

This study examined the relationships between students' perceptions of teaching approach, mathematics anxiety, career aspirations, and academic achievement by analysing self-reported questionnaires from senior two students in Musanze, Rwanda. The two research objectives were achieved. First, examined the mediating role of mathematics anxiety and career aspirations on the relationships between students' perceptions of teachers' teaching approach and academic performance. Only mathematics mediated the effect of students' perceptions of teachers' teaching approach and on their academic performances. Secondly, when we considered the effects of students' gender, we found no gender differences among senior two students, which provided new insights into how the study variables relate. The results of this study not only provide theoretical contributions but also may help educators, policymakers, and administrators to rethink the role of students' perceptions of teacher's teaching approach and find more effective interventions to motivate lower secondary students to take mathematics-related courses and reduce their mathematics anxiety, which in turn could improve their academic performance for male and female students.

While this study is, as far as we know, the first of its kind to examine the structural relationships between students' perceptions of mathematics teaching, mathematics anxiety, academic achievement, and aspirations for mathematics-related careers in the Rwandan context, it by no means exhausts all the factors that influence career choices and academic performance. Therefore, more longitudinal surveys should be designed to examine growth trajectories related to students' perceptions of mathematics teaching, mathematics anxiety, and academic performance in Rwandan secondary schools.

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Appendix 1: Students' questionnaire

Gender: M F

Dear student;

Thank you for accepting to participate in this study that aims to understand what you think and feel about your teacher's teaching approach and your motivation to learn Mathematics. You will provide your answers by rating each of the proposed statements by ticking one of the five scales that most suits your judgment (Strongly Agree, Agree, Neutral, Disagree, or Strongly Disagree). We request you to be as much as honest as you can because your answers will be treated with the utmost confidentiality and will be solely used for research purposes only. So, do not mention your names anywhere on this questionnaire. Please also note that there is no right or wrong answer here.

Item		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Perceptions of Teacher's Teaching Approach						
1.	The way my teacher teaches mathematics makes me love it.					
2.	Teacher's teaching practices make mathematics simple and easy to understand.					
3.	I feel bored in the mathematics class because does not connect mathematics with real life.					
4.	I like the way teacher uses real objects and examples to explain abstract concepts in mathematics.					
5.	Mathematics teacher does not keep my attention because of giving only formula without explaining—I get bored					
Career Aspirations						
6.	My career will involve mathematics					
7.	Knowing mathematics will give me a job advantage					
8.	I will use mathematics problem solving skills in my career					
9.	Learning mathematics will help me get a good job					

10.	Understanding mathematics will benefit me in my career					
Mathematics anxiety						
11.	I am nervous about how I will do on the mathematics tests.					
12.	I become anxious when it is time to take a mathematics test.					
13.	I worry about failing the mathematics tests.					
14.	I am concerned that the other students are better at mathematics.					
15.	I hate taking the mathematics tests.					

Thank you for your time

Table 4: Reliability, validity, and descriptive statistics of measurement items

Latent Variable	Item	Item wording	M	SD	Skew	Kurtosis	LF	R^2
Mathematics performance (MP)	MP	-----------------------------------	2.35	1.03	0.82	0.44	1.00	1.00
Mathematics Anxiety (MA; $\alpha = 0.78$, AVE:0.58, CR:0.81)	MA1	I am nervous about how I will do on the mathematics tests.	3.69	1.05	-0.52	-0.09	0.56	0.31
	MA2	I become anxious when it is time to take a mathematics test.	3.56	1.21	-0.33	-1.00	0.57	0.32
	MA3	I am concerned that the other students are better at mathematics.	3.55	1.11	-0.50	-0.48	0.66	0.44
	MA4	I worry about failing the mathematics tests.	3.70	1.20	-0.68	-0.45	0.72	0.51
	MA5	I hate taking the mathematics tests.	3.93	1.13	-0.99	0.28	0.74	0.54
Career Aspiration (CA; $\alpha = 0.76$, AVE:0.56, CR:0.72)	CA1	My career will involve mathematics	2.19	1.01	0.68	0.11	0.68	0.46
	CA2	Knowing mathematics will give me a job advantage	2.20	1.01	0.69	0.16	0.69	0.48
	MA3	I will use mathematics problem solving skills in my career	2.11	0.94	0.57	-0.11	0.61	0.37
	CA4	Learning mathematics will help me get a good job	2.25	1.09	0.72	-0.09	0.62	0.38
	CA5	Understanding mathematics will benefit me in my career	2.65	1.17	0.45	-0.49	0.51	0.26
Perceptions of Teacher's Teaching Approach (PTTA; $\alpha = 0.82$, AVE:0.62, CR:0.89)	**PTTA1**	The way my teacher teaches mathematics makes me love it.	2.25	1.08	0.67	-0.15	0.69	0.48
	PTTA2	My teacher's teaching practices make mathematics simple and easy to learn.	2.26	1.09	0.76	0.04	0.62	0.39

	PTTA3	I feel bored in the mathematics class because does not connect mathematics with real life.	2.15	1.02	0.73	0.07	0.63	0.40
	PTTA4	I like the way the teacher uses real objects and examples to explain abstract concepts in mathematics.	2.18	1.03	0.73	0.19	0.64	0.42
	PTTA5	Mathematics teacher does not keep my attention because of giving only formulas without explaining—I get bored	2.20	1.04	0.71	0.13	0.65	0.43

Note: R^2=Item Reliability, LF=loading factor, AVE= average variance extracted, CR=composite reliability, M=Mean, SD=Standard deviation

Table 2: Multi-Group Measurement Invariance Analysis

	χ^2	Df	CFI	SRMR	RMSEA	TLI
Male	1237.134	114	0.970	0.045	0.042	0.964
Female	1657.592	114	0.950	0.044	0.052	0.950
Configural Invariance	338.30	228	0.958	0.045	0.048	0.950
Metric Invariance (Equal loadings)	353.22	241	0.957	0.053	0.047	0.952
Scalar Invariance (Equal intercepts)	363.86	254	0.958	0.054	0.046	0.955
	$\Delta\chi^2$	ΔDf	ΔCFI		$\Delta \boldsymbol{RMSEA}$	P-value
Configural	-----------		--------		-----------	-------
Configural Vs. Equal loadings	14.919	13	0.001		0.001	0.312
Equal loadings Vs. Equal intercepts	10.646	13	0.001		0.002	0.640