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Antecedents Of Student's Motivation For Learning Mathematics And Its Effect On Their Proficiency In Mathematics

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Abstract

Student achievement is predicted by school climate, parental involvement, positive attitude, and motivation. However, most studies have looked at these factors separately and very few have looked at how Mathematics achievement and motivation interact as determinants of student mathematical proficiency. Studies have indicated a correlation between students' attitudes towards mathematics and their level of motivation (Wang, Zhang & Cai,2021). This study seeks to close this disparity by examining internal elements (school climate, parental involvement, positive attitude) influencing mathematical proficiency through motivation at lower secondary school levels for both the public and private sectors. We gathered data from 303 male and 251 female students of grades 6 to 9 from public and private schools using an online self-administered Google form. We used 554 valid sample cases out of 602 for hypothesis testing through SmartPLS. The findings from the data analysis indicate that school climate, positive attitude towards mathematics, and parental involvement exert substantial influences on student motivation. Moreover, student motivation is found to be a significant predictor of student mathematical proficiency. Additionally, the research findings state that parental involvement is moderately correlated with (1) students' attitudes toward mathematics (2) mathematical proficiency test scores and (3) mathematical performance assessment scores. We thus recommend that mathematics teachers as well as school management create a school climate that is conducive to enhancing students' mathematical proficiency. This is possible by making mathematics teaching a joint venture; where teachers motivate students to study mathematics and develop among them a positive attitude towards mathematics and school management involve parents, teachers and students to make informed decisions concerning students' proficiency during mathematics classes.

Keywords Mathematics Proficiency. School Climate. Motivation. Positive Attitude. Parental Involvement.

I Introduction

Mathematics accomplishment holds significant value as an indicator of academic triumph among lower secondary and secondary students due to various reasons, including college or university admissions. While numerous factors impact students' mathematics achievement, school climate, parental involvement, positive attitude and motivation have been a matter of discussion in this study.

According to a survey conducted by ASER (2021) in 25 rural districts of Sindh (660 public and 114 private schools), only 28 percent of grade 5 students could do 2-digit division as compared to 31 percent in 2019, whereas 7 percent children enrolled in grade 3 could do 2-digit division as compared to 8 percent in 2019. This is a clear indication that the mathematical performance of students is drastically decrementing each subsequent year. The National Assessment Test (NAT) conducted by the National Education Assessment System; Government of Pakistan (NEAS, 2014) assessed the achievement for students in mathematics. The mean score achieved by the students enrolled in grade 8 was 46.1 percent which indicates the need for hard work to enhance student's learning. Out of four provinces, only Punjab showed an average score of 53.2 percent (Ailaan, 2017). In Sindh, the province's Standardized Achievement Test (SAT) results for 2016 showed that the average mathematics scores for grade 8 were 24 percent. The overall subject score in mathematics was reported to be 22 percent for all five content strands including numbers, algebra, measurement, geometry and information handling (SAT, 2016).

Schooling is an intricate concept which goes beyond transmission of knowledge, skills and attitude (Sandra, John & Gavin, 2013). Researchers attempted to identify the relationship of affective factors within schools that promote academic achievement enhancement (Ainley, 1999; Anderson & Bourke, 2000). Recent studies have reported students' low performance in mathematics due to different predictors. In a Nigerian context, research conducted by Adeneye and Awofala (2021) revealed that students' mathematics performance falls below societal expectations. Consequently, many students face difficulties in gaining admission to universities, as mathematics proficiency is utilized as a crucial criterion for university admissions in Nigeria. (Awofala & Lawani, 2020). The poor mathematical performance may be due to teaching of procedure and algorithms in isolation effecting basic knowledge and conceptual understanding of students in schools (Awofala, 2017). The researchers recommended that mathematical proficiency should be a primary goal of effective mathematics teaching and learning in schools. Our study also deals with predictors like school climate and positive attitude towards mathematics which effect on student's motivation to perform in mathematics classes.

In the Brazilian context, a study conducted by Gomes, Fleith, Marinho, and Rabelo (2021) revealed that secondary-level students exhibited subpar mathematics performance in national examinations such as the National Exam for Secondary Education (ENEM), the Basic Education Assessment System (SAEB), and the Programme for International Student Assessment (PISA). The researchers examined the predictive factors for mathematics achievement in secondary education, emphasizing the influence of school and family. In this present study, we focused on parental involvement as a predictor of students' mathematical proficiency through motivation.

During their study in the Greek context, Hiller, Cheema, and Poulou (2021) identified "mathematics anxiety" and "self-efficacy" as factors that predict mathematics literacy. The study's findings revealed a noteworthy correlation between mathematics anxiety, mathematics self-efficacy, and mathematics performance. In contrast, our study focuses on investigating motivation, which stands in

opposition to mathematics anxiety, as a predictor of mathematics achievement.

It is necessary to contemplate the reasons behind the underperformance of students at the lower secondary level in both public and private sectors in Pakistan when it comes to Mathematics. This study explores the factors contributing to students' inadequate mathematical proficiency. There are various challenges that can impact students' performance in mathematics, with the most noteworthy factor being the students' unfavourable attitude towards the subject (Simegn & Asfaw, 2017). Attitude towards mathematics plays an important role in understanding mathematics. It determines the learner's achievement. Students with a positive attitude towards mathematics, score higher than the students who have a negative attitude towards the subject. Contrary to this a study conducted by Bekele (2015) holds that higher achievement can predict a positive attitude of a student towards mathematics but it cannot do vice-versa Bekele justifies his statement by saying that there are students having a positive attitude for mathematics but their performance is very poor. But most of the research done worldwide shows that mathematics achievement and students' positive attitude strongly correlate with each other.

In Pakistan where the literacy rate is low, pupil teacher ratio is uneven, subject expert teachers are scarce and parents are uneducated, it is difficult for students who lack mathematics competency to get help from parents and teachers for the improvement of the grey areas in the relevant subject. Even though, students are taught by the same teacher, in the same learning environment, yet are unable to do simple calculations. The lead researcher throughout his teaching career encountered a lot of students (male and female) who developed a fear of mathematics because they simply could not get help when they needed it most. Anxiety, motivation, self-efficacy, parental involvement and so on, effect a student's proficiency. This raises the question of why students demonstrate low performance and what factors contribute to their mathematics achievement. This study addresses this inquiry by identifying the factors that influence the mathematical proficiency of lower secondary students in Karachi, Pakistan. This study therefore aimed to:

- Analyze the impact of overall school climate on student motivation towards mathematical proficiency.
- Examine the effect of positive attitude on student motivation towards mathematical proficiency.
- Examine the impact of parental involvement on student motivation towards mathematical proficiency.
- Analyze the effect of student motivation on mathematical proficiency.

2 Review of Existing Literature and Hypotheses

2.1 Theoretical Framework

The current research was guided by the self-determination theory (SDT) introduced by Ryan and Deci. This theory holds that motivation (either extrinsic or intrinsic) is affected by external and internal factors. According to the theory, individuals can attain a state of self-determination when their needs for competence, connection, and autonomy are met. The underlying premise of the theory is that the desire for personal growth propels one's actions. As a result, people are driven by both external rewards and internal sources of motivation, as explained by Bhavsar (2020). In order to study the impact of students' motivation on their mathematics proficiency, it was necessary to identify which of the external and internal factors motivates a student to achieve a good score in mathematics, in other words help them become mathematically proficient in the subject. Therefore, a

conceptual framework was developed (Refer to Figure 1.1) that included school climate and parental involvement as external factors and student's positive attitude as internal factor that affect student motivation which ultimately increases students' mathematical proficiency.

2.2 School Climate and Student Motivation

The definition of school climate frequently varies across different studies. (Grazia & Molinari, 2021; Nilsen & Teig, 2022). In a recent study conducted by Nilsen, Kaarstien, and Lehre (2022), a positive school climate is characterized by four key elements: a secure and safe environment, a strong connection with the community, a conducive academic environment, and a well-functioning institutional environment.

Given that school climate encompasses various dimensions, including observable school characteristics, organizational structure, and the attitudes, beliefs, and values within a school (Dorio, Bradshaw & Demaray, 2019), it is advisable for researchers to concentrate on specific aspects or a subset of these dimensions. (Wang & Degol, 2016).

An 'inviting climate' is essential for challenging and enjoyable learning. (Bourke 1993; Hattie 2009b; Leonard et al., 2002). Programme for International Student Assessment (PISA) reports that the classroom environment plays a significant role in a student's school life (Schleicher 2002).

For an effective school climate, the quality of the teacher-student relationship is a matter of great concern. Teachers who are respectful to their students, take care of their learning, provide socio-emotional and intellectual support, keep the students engaged and have a positive approach towards academic tasks are able to gain student's trust and develop an optimistic self-perception among students related to achievement (Deci & Ryan 2002; Wigfield et al., 2006.) Thus the following hypothesis was formulated:

H_1: School climate has a significant effect on student motivation

2.3 Positive Attitude and Student Motivation

Students' attitudes toward learning strongly impact their motivation to learn, achieving goals, and attaining satisfaction. Motivated learners take proactive measures to initiate learning in order to accomplish their goals, and they derive satisfaction from and persevere in the learning processes (Chen, M. et al., 2022). Simegn and Asfaw (2017) define attitude as an effective response to a behaviour that is initiated by motivation. They hold that attitude towards learning of any subject is directly linked with motivation because it provides information to a better understanding of the attitudinal and motivational process of a learner (p. 58). McLeod (1992) on the other hand defined the term attitude as positive or negative feelings of moderate intensity and reasonable stability (p.581). Generally, attitude refers to an individual's belief and feeling about mathematics. Attitude towards mathematics has been defined as a positive or negative feeling for mathematics. (Zan & Martino, 2007, p.158). According to Nicolaidou and Philippou (2003), positive attitude towards mathematics and the achievement are strongly correlated. Students learn better when they take interest in the subject.

Attitudes (positive or negative) can be learned through observations or acquisition of knowledge, competencies and proficiencies. (Yilmaz, Altun, & Olkun, 2010, p.4). According to Zan & Martino (2007), the construct (attitude) comes from social psychology, and foresees a student's choice. Emotions and beliefs deeply interact with attitude and are explicitly recognized in the construct. To learn mathematics, a student must develop a positive attitude towards the subject because it determines the likeness or dis-

likeness and therefore plays a vital role. Having a positive or negative attitude toward mathematics depends on how a student perceives the subject. Students may develop a positive disposition towards mathematics by showing likeness toward it; whereas a negative disposition is shown by a student's dis-likeness towards it.

An individual's attitude (positive or negative) is measurable through attitudinal scales (e.g., Likert or Thurstone) in which a score is attached to items leading to a positive or negative evaluation. Attitude towards a subject is shown by emotion (e.g., I like mathematics), belief (e.g., mathematics is useful) and behavior (e.g., I always do my mathematics homework). A positive or negative response depends on the perception of attitude as emotion, belief, or behavior. When an attitude is referred to as emotion, a positive attitude is perceived as pleasure which minimizes mathematical anxiety in students. A student's accomplishment (proficiency) is a reflection of their positive attitude towards a subject. Within an educational context, a favorable attitude towards a subject is commonly associated with achieving high scores or demonstrating proficiency in that particular subject (Middleton & Spanias, 1999).

H2: Positive attitude has a significant effect on student motivation

2.4 Parental Involvement and Student Motivation

Recent Studies (e.g., Cai, 2003; Kirk et al., 2011; Lay et al., 2015; Levpušček & Zupančič, 2009; Phillipson & Phillipson, 2012) have shown that parental involvement has an effect on mathematics achievement, mathematics learning, motivational beliefs about mathematics and mathematical self-efficacy (Wang , Zhang & Cai, 2021).

Students whose parents actively participate in their education exhibit greater proficiency in mathematics compared to students whose parents have lower levels of involvement (Boonk, et al., 2022). The impact of parental involvement on students' academic achievement has been a subject of interest among social educational researchers for a considerable period of time (Fan and Chen, 2001, p.2). Parental involvement includes monitoring students work at home, helping them solve problem questions, inquiring about test results, encouraging the children to score well, discussing progress with the teacher, discussing their child's future as a commerce or science students, guiding them to select a program or course offered at school and volunteering in programs organized by schools (Benner, Boyle, & Sadler, 2016). Students who receive parental encouragement and actively engage in their education display increased interest in academic work, as well as demonstrate more positive attitudes and higher aspirations (Epstein, 1992) because parental involvement impacts a students' academic achievement and therefore is an essential ingredient for a better education.

Experience with peers and family play a constructive role in cognitive development of a child. A child relates the real world with their surroundings. When children actively participate in interactions with others and their surroundings, they integrate new information and adjust their understanding by correcting any inaccurate perceptions of the world (Prior & Gerard, 2007). Optimal learning for children occurs through active engagement with their parents. Parental involvement plays a crucial role in a student's development and academic achievement. Additionally, various social and cultural factors exert influence on a student's learning process. (Vygotsky, 1978, as cited by Tekin, 2011, p.6). People gain knowledge through interaction with society. Family plays a central role in the process of making sense of things. A student may have a different zone of proximal development (ZPD) which perceives a learner as an independent and dependent learner. Vygotsky claimed that students are capable to learn and succeed independently at a

certain stage however they need the supervision of an adult to complete their task (interdependence). Therefore, a child's atmosphere, especially parents' involvement is a contributing factor in academic achievement (Prior & Gerard, 2007).

H3: Parental involvement has a significant effect on student motivation

2.5 Student Motivation and Mathematical Proficiency

Educational psychologists recognize motivation as an essential factor to support students' effective learning. It is a source of energy responsible for the efforts made by the students to learn a concept. It provides will power to the students to participate in a learning activity. Motivation works as an ignition to sustain positive energy leading to ultimate success (Simegn & Asfaw, 2017).

According to a recent study, there is a need to support students' confidence and reduce negative emotional responses to mathematics tasks. Motivated students pose questions to clarify their concepts and to improve their learning. Problem posers show a desire to extend their own mathematical thinking, express dissatisfaction with their current knowledge and direct their problems towards the teacher (Headrick,. et al., 2020)

Based on empirical evidence, positive emotions such as enjoyment are interconnected with aspects such as academic interest, motivation, engagement, and achieving high levels of success (Krapp, 2000; Pekrun, 2006, Pekrun, 2017). Contrarily, negative emotions (such as boredom) lower intrinsic motivation, attention, and interest and are linked to surface learning (Pekrun, 2017).

Research consistently reveals that a misalignment between students' needs and the opportunities provided by the school during the transition from primary to secondary education often leads to a decline in academic interest, motivation, engagement, and achievement (Held & Hascher, 2022). This unfavourable shift contributes to negative academic outcomes, school disengagement, and ultimately, an increased risk of dropping out (Hascher & Hadjar, 2018). Moreover, a recent study conducted by Hammad, Graham, Dimitriadis, and Taylor (2022) suggests that successful mathematics classrooms play a significant role in fostering students' motivation and achievement.

Studies identify the chain effect that motivation has on competency. Researchers hold that motivation effects effort, effort effects result and result effects success. A self-determined person is able to take an action because he perceives a concept in a certain way. Attitudes allow people to achieve set objectives. Cross-cultural research has shown that satisfaction of the student's needs is necessary for the development of a healthy personality (Gagne & Deci 2014). The fulfillment of students' needs (psychological or social), safety, esteem and self-actualization motivate a student to learn and develop a positive attitude towards a subject as it is an internal condition that directs behaviour.

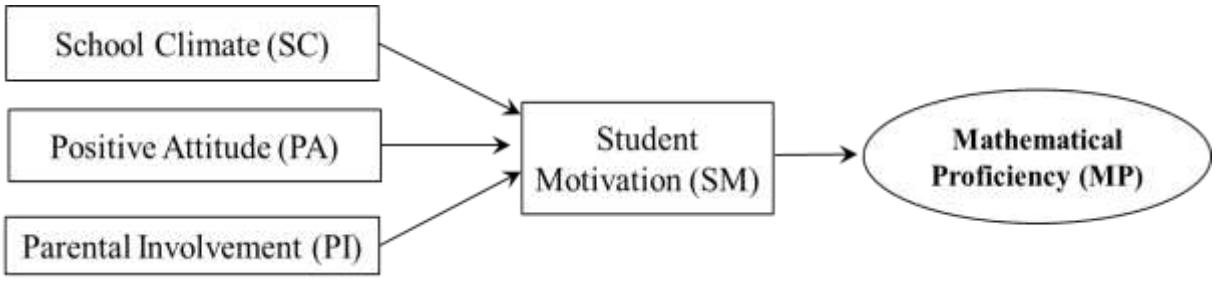
According to Cognitive Evaluation Theory (CET), factors such as achievement and responsibility intrinsically motivate a person whereas promotion, feedback and study environment function as extrinsic motivators. Intrinsically motivated students work for their own personal growth. CET explains that Improper reward diminishes intrinsic motivation and has a negative impact on proficiency (Jitin, 2015). Despite being awarded with good marks some students get demotivated because scoring good marks is not their objective. Scores do not excite them, therefore rewards in their case may decrease motivation and impact proficiency.

H4: Student motivation has a significant effect on student mathematical proficiency.

Framework of the study

The research model incorporates the variables; school climate, motivation, positive attitude towards mathematics and parental involvement. Figure 1 shows the internal and external variables that impact a students' achievement (proficiency) in mathematics. The study investigated the inter-relationship among variables and its impact of mathematical proficiency. The model in Figure 1 shows the impact of two external factors, including, school climate and parental involvement, and two internal factors, that is student motivation and students' positive attitude towards mathematics on students' mathematics proficiency. In this framework, student motivation is considered as a mediator.

Figure 1 Framework of the study



3 Method

3.1 Sample and Procedure

The primary objective of this paper is to examine the correlation between school climate and student motivation with mathematical proficiency. Additionally, it aims to investigate the associations between student's positive attitude towards mathematics and student motivation with mathematical proficiency, as well as parental involvement and student motivation with mathematical proficiency. The data were collected from lower secondary students of grades 6 to 9, Catholic Board of Education Karachi (CBEK) schools. The reason to select only the CBEK schools was to conduct a study in one of the settings where all the students come from similar socio-economic backgrounds and where language and technology were not a hindrance to conducting data. Secondly only selective CBEK school students took part in the study because the method to collect data involved the use of Computer Lab with the availability of internet connection with each computer. Similarly, one of the public schools was selected where the students from grades 6 to 8 were available and feasibility of Computer Lab was possible. To assess and investigate the influence of the relationships among the multiple variables under scrutiny, a quantitative research methodology was employed in this study. The relationships between school climate, a positive attitude toward mathematics, and student motivation for math proficiency, as well as parental involvement and student motivation for math proficiency was studied using correlational research design.

After seeking a formal written approval from the head of six private elementary schools administered by the Catholic Board of Education and one public elementary school located in Karachi, Pakistan, the data were collected on a survey questionnaire from their students. All of these seven schools have been operating in the city for the last 50 years. Out of 602 self-administered questionnaires received one unengaged form was excluded. The final response rate was 92%. Besides, after removing 47 multivariate outliers at 99.99% CI ($p<.001$) following the guidelines of

Tabachnick and Fidel (2014), the usable data were 554. A detailed account of the sample size is mentioned in Table 1.

Table 1: Demographic Profile (n= 554)

Demographic	Description	Count	%
Gender	Male	303	54.7
	Female	251	45.3
Grade Level	6	154	27.8
	7	129	23.3
	8	115	20.8
	9	156	28.2
Sector	Public	223	40.3
	Private	331	59.7
Mathematics Achievement Test	50% to 60%	161	29.1
	61% to 70%	107	19.3
	71% to 80%	120	21.7
	81% to 90%	91	16.4
	91% to 100%	70	12.6
	Less than 50%	5	0.9

Measure

To measure 5 latent variables (LVs), a total of 28 questionnaire items were adapted from previous studies out of which 5 items measured the perceived school climate (example: I am put down by other students in my class, I do not feel safe in my school) , 5 items measured the perceived student's motivation (example: I totally get absorbed in mathematics, I can master mathematics skills), 5 items determined the perceived positive attitude towards mathematics (example: mathematics helps me to solve daily life problems, I feel comfortable with numbers and symbols), 5 items measured the perceived parental involvement (example: I believe parental support help in scoring well in mathematics, I believe parental involvement help in solving difficult problems in mathematics) and 8 items measured the perceived mathematical proficiency (example: I am able to connect idea to what I already know, I know what symbols in mathematics mean). A 5-point Likert Scale was employed to gauge the degree of agreement, utilizing the following descriptors: 1 = strongly agree, 2 = agree, 3 = undecided, 4 = disagree, and 5 = strongly disagree. The overall reliability of all variables was calculated to be $\alpha = 0.810$, surpassing the acceptable threshold of 0.7 (Hair et al., 2011) and indicating a highly satisfactory level (Hulin, Netmeyer & Cudeck, 2001).

4. Data Analysis

The study's primary goal is to measure and analyze the proposed conceptual model. Data analysis is used to evaluate hypotheses with the use of numerous statistical techniques. The data screening step was first conducted using SPSS. Second, SmartPLS4 was used to conduct hypothesis testing in order to observe effects. After the data screening method was completed, SmartPLS 4 was used to do further data analysis. Three processes were followed for the analysis: first, building the model in SmartPLS4, then assessing the validity of the outer measurement model, and last, establishing the validity of the inner measurement model.

4.1 Measurement Model Assessment

The findings on reliability are presented in Table 2, which displays the composite reliability (CR) value for each latent variable. It is worth noting that the overall reliability of all variables exceeded the threshold of 0.7 (Hair et al., 2011).

4.1.1. Reliability Testing

The concept of "reliability" pertains to the consistency of something (Neuman, 2007). To evaluate reliability, composite reliability was utilized as a measure. It is considered a more reliable indicator of internal consistency compared to Cronbach's alpha (Hair et al., 2014). In this study, reliability serves as a measure of internal consistency. A construct is deemed reliable when the value of composite reliability (CR) exceeds .70 (Hair et al., 2013).
A total of 28 indicator items were used on a five-point Likert scale anchoring from 1 = Strongly Agree and 5 =Strongly Disagree. The results revealed that, School Climate Scale with 2 out of 5 items (CR= .815), Student's Positive Attitude towards Mathematics scale with 5 out of 5 items (CR=.879), Parental Involvement Scale with 4 out of items 5 (CR= .735), Student's Motivation Scale with 4 out of 5 items (CR=.819) and Student's Mathematical Proficiency Scale with 7 out of items 8 (CR =.895) were found reliable. The findings on reliability are presented in Table 2, which displays the composite reliability (CR) value for each latent variable. It is worth noting that the overall reliability of all variables exceeded the threshold of 0.7 (Hair et al., 2011).

Table 2: Reliability Testing and Convergent Validity

Constructs	Items	Loadings	P Values	CR	AVE
School Climate (SC)	SC4	0.793	0.000	0.815	0.689
	SC5	0.865	0.000		
Positive Attitude (PA)	PA1	0.809	0.000	0.879	0.593
	PA2	0.819	0.000		
	PA3	0.718	0.000		
	PA4	0.717	0.000		
	PA5	0.781	0.000		
Parental Involvement (PI)	PI1	0.699	0.000	0.831	0.553
	PI2	0.804	0.000		
	PI3	0.801	0.000		
	PI4	0.660	0.000		

Student Motivation (SM)	SM1	0.717	0.000	0.819	0.531
	SM2	0.697	0.000		
	SM3	0.731	0.000		
	SM4	0.769	0.000		
Mathematics Proficiency (MP)	MP1	0.719	0.000	0.895	0.55
	MP2	0.788	0.000		
	MP3	0.752	0.000		
	MP4	0.788	0.000		
	MP5	0.713	0.000		
	MP6	0.729	0.000		
	MP7	0.694	0.000		

Notes: CR= Composite Reliability; AVE=Average Variance Extracted

4.1.2 Convergent Validity

Convergent validity is evaluated by employing the average variance extracted (AVE) method (Hair et al., 2011). It is expected that the AVE criterion should be at least 0.5, and factor loadings for convergent validity should be a minimum of 0.7 (Hair et al., 2014). The outcomes of the AVE analysis are showcased in Table 2, where all values surpass the threshold of 0.5. Table 2 demonstrates that all mentioned constraints align with the assumptions of convergent validity.

4.1.3 Discriminant Validity

Discriminant validity assesses the degree of differentiation between different constructs (Hair et al., 2014). Ensuring discriminant validity is essential for obtaining reliable results and identifying any extreme outliers (Henseler et al., 2015). The Fornell and Larcker criterion, the Heterotrait-Monotrait ratio, and cross-loading analysis are utilized to establish discriminant validity (Hair et al., 2014; Henseler et al., 2015). According to the Fornell and Larcker criterion, a variable should exhibit greater variance with its own items compared to other variables (Hair et al., 2014). Table 4 presents the square root of the average variance extracted (AVE) values on the diagonal, which should be higher than the inter-construct correlation (Hair et al., 2011).

Table 3 presents the correlation matrix, indicating the presence of discriminant validity. Nevertheless, alternative research suggests that the Fornell and Larcker approach may not be suitable for assessing discriminant validity in certain circumstances. In response to this, Henseler et al. (2015) introduced a new method known as the Heterotrait-Monotrait ratio of correlations (HTMT) to validate discriminant validity. If the HTMT value is below 0.9, it confirms the existence of discriminant validity (Henseler et al., 2015).

Table 3: Discriminant Validity using Fornell and Larcker (1981) Criterion

Constructs	PI	SC	SM	PA	MP
PI	0.744				
SC	0.254	0.830			
SM	0.450	0.303	0.729		
PA	0.607	0.266	0.534	0.770	
MP	0.680	0.295	0.498	0.693	0.741

Notes: PI = Parental Involvement; SC = School Climate;

SM = Student Motivation; PA = Positive Attitude; MP = Mathematical Proficiency

Table 4 presents the results of the HTMT analysis, which confirm the presence of discriminant validity. Another approach to verify discriminant validity is to examine the cross-loadings of items. It is important that each item demonstrates higher cross-loadings within its own construct compared to cross-loadings on other constructs (Hair et al., 2011; Hair et al., 2014). According to Gefen, Straub & Boudreau (2000), there should be a 0.1 difference between cross-loadings on each construct and loadings on other constructs. The cross-loadings of all variables are shown in Table 2.

Table 4: Discriminant Validity using Heterotrait-Monotrait Ratio ($HTMT_{0.85}$)

Constructs	PI	SC	SM	PA	MP
PI					
SC	0.385				
SM	0.592	0.472			
PA	0.775	0.397	0.677		
MP	0.839	0.434	0.621	0.820	

Notes: PI = Parental Involvement; SC = School Climate;
SM = Student Motivation; PA = Positive Attitude; MP = Mathematical Proficiency

4.2 Hypothesis Testing

After assessing the outer model measurement, the data is then examined to determine the internal model measurement. This process is based on the research by Henseler et al. (2015) and Hair et al. (2011). To test the hypotheses, the bootstrapping method, specifically the Partial Least Square (PLS) approach introduced by Haenlein and Kaplan (2004) is employed. Through this resampling technique, numerous smaller subsets (usually 5000 or greater) are randomly selected from the original data, as explained by Hair et al. (2014).

A variance-based structural equation modelling is applied to analyze the effect of School Climate (SC), Positive Attitude (PA), Parental Involvement (PI) on Student Motivation (SM) and in turn, on Mathematical Proficiency (MP). Table 5 shows that SC, PA and PI have significant effects on SM (β= 0.155, t-value =4.055***; β=0.386, t-value = 6.844***; β= 0.176, t-value = 3.490**) respectively, therefore H1, H2 and H3 are supported. Moreover, SM has also shown a significant effect on MP (β= 0.498, t-value =11.751***) therefore H4 is also supported.

Table 5: Hypothesis testing using VB-SEM

No	Hypothesis	Estimate	SE	t values	p values	Decision
H1	SC ➔ SM	0.155	0.038	4.055	0.000	Supported
H2	PA ➔ SM	0.386	0.056	6.844	0.000	Supported
H3	PI ➔ SM	0.176	0.051	3.490	0.001	Supported
H4	SM ➔ MP	0.498	0.042	11.751	0.000	Supported

Notes: SE = Standard Error; PI = Parental Involvement; SC = School Climate; SM = Student Motivation; PA = Positive Attitude; MP = Mathematical Proficiency

4.2.1 Model Assessment Criteria

The quality of the internal model is determined by its ability to accurately predict the endogenous construct, as discussed by Hair et al. (2014). Essential criteria for evaluating an internal model are the coefficient of determination (R^2) and cross-validated redundancy (Q^2), as highlighted by Hair et al. (2011, 2014) and Henseler et al. (2009). R^2 serves as a measure of the model's predictive accuracy. It represents the overall impact of the exogenous (independent) variable on the endogenous (dependent) variable, as explained by Hair et al. (2014). R^2 is categorized into three levels: high, moderate, and low. A value above 0.6 indicates a high R^2, while a value between 0.3 and 0.6 indicates a moderate R^2. A value below 0.3 indicates a low R^2. The R^2 values for the model's fit can be found in Table 6. Another method for assessing model accuracy is cross-validated redundancy (Q^2), which evaluates the predictive value of the internal model, as discussed by Hair et al. (2014).

Table 6: Model Assessment Criteria

Constructs	R^2	Adjusted R^2	Q^2
SM	0.332	0.328	0.169
MP	0.248	0.247	0.132

Notes: SM = Student Motivation; MP = Mathematical Proficiency

The blindfold method is employed to measure Q^2. It is expected that the Q^2 value is positive, indicating a well-fitted model. The values of Q^2 can be found in Table 6, which confirms the adequacy of the model since all values are greater than zero. For Student Motivation (SM), the R^2 value is 0.332 and the Q^2 value is 0.169. Similarly, for Mathematical Proficiency (MP), the R^2 value is 0.248 and the Q^2 value is 0.132.

5. Discussion

The research investigates how School Climate (SC), Positive Attitude (PA), and Parental Involvement (PI) influence Student Motivation (SM), and subsequently, how Student Motivation (SM) affects Mathematical Proficiency (MP). With a total of four hypotheses, the outcomes from both the measurement and structural models exhibit a high level of compatibility with the collected sample, indicating a strong fit.

The initial three aims of the current study involved examining the impact of school climate, positive attitude, and parental involvement on student motivation. The findings of the study suggest school climate ($t = 4.055$, $p = 0.000$), positive attitude ($t = 6.844$, $p = 0.000$) and parental involvement ($t = 3.490$, $p = 0.001$) are positively correlated with student motivation. As a result, H1, H2, and H3 received confirmation and were supported. Conversely, a positive correlation between student motivation and mathematical proficiency ($t = 11.751$, $p = 0.000$) was discovered, thereby providing support for H4.

It is inferred that students are motivated when they have a good and healthy school climate, have a positive attitude towards the subject being studied and have a good support from parents being involved in their learning process. The findings of the study also suggest that highly motivated students are more proficient in mathematics and achieve better scores than those who are less motivated or otherwise anxious.

According to a study by Lahaie (2008), students with the most supportive parents

demonstrated greater mathematical achievement and more positive attitudes about mathematics than students with the least supportive parents. According to this study's findings, parental involvement is moderately correlated with positive attitudes toward mathematics ($r = 0.24$, $p<0.01$), mathematical proficiency test scores ($r = 0.22$, $p<0.01$), and math performance assessment scores ($r = 0.25$, $p<0.01$). The possible reason for this moderate correlation may be the lack of parents either being illiterate or less educated considering the literacy rate of Pakistan. The second reason of parents are unable to provide support to their children is due to economic constraints, which compels both parents to work in the metropolitan city of Karachi.

5.1 Theoretical Contribution

The study contributes to the body of knowledge by examining factors. The internal factors include positive attitude and motivation and their impact on student mathematical proficiency. The external factors include school climate and parental involvement which play a significant role to improve student mathematics proficiency. This finding is aligned is SDT theory by Ryan and Deci (2000) which identifies the significant role of motivation to fulfil the psychological needs of students which are autonomy (measured through the construct of positive attitude), competence (measured through the construct of mathematical proficiency) and relatedness (measured through the construct of parental involvement).

5.2 Practical Implications and Recommendations

Based on the findings, a variety of practical applications are possible. First, it is crucial for educators to effectively teach their students in order to enable them to demonstrate high academic performance. In order to accomplish this goal, educators must have a greater understanding of the elements that may influence students' academic progress. Second, it involves a challenging and complex effort to identify all the affecting factors simultaneously. An educator ought to consider all these factors prior to developing lesson plans and teaching and learning strategies. This necessitates a considerable amount of time and resources. The variables' identification must be given full attention and priority in order for the teachers to be able to develop instructional strategies that will ensure that every child has the chance to reach their full potential in learning and performance. This requires proper training, and skills development to conduct such studies for identifying the contributing factors inside and outside of school. Additional research is necessary to explore the issue in-depth by utilizing a substantial sample from various geographically diverse geographical locations. It is important to consider factors such as peers, family, and potentially other relevant variables in future investigations.

6 Conclusion and Recommendations

The current research specifically aims at mathematics proficiency as a measure of mathematics achievement. Most of the previous researchers have considered using a teacher-made test or a standardized test to measure achievement or academic performance whereas in actuality the main objective to teach mathematics is to induce essential skills and competencies in students enabling them to do the necessary tasks to achieve the set objectives by the state. The study was limited being conducted in only one of the educational systems i.e. CBEK schools, it would be better if the study was open to many other school systems and a generalized result could have been taken. Since the researcher used a questionnaire as a tool for data collection, an in-depth analysis could not be achieved.

6.1 Recommendation for Educators

Previous research on mathematics proficiency and achievement has identified the incompetency of the mathematics teacher to develop conceptual development among students that work as a foundation stone for

mathematical learning. It is important for mathematics educators to teach mathematics while keeping the five interwoven and interdependent strands of mathematics that are conceptual understanding, productive disposition, procedural fluency, strategic competence and adaptive reasoning. Educating students using these strands not only improves mathematics proficiency but also improves mathematical achievement.

6.2 Recommendation for School Management

School managers are recommended to create a conducive mathematical environment as the climate has a significant effect on student motivation and achievement. It is essential that the students studying a rigorous and disciplined subject like mathematics have an element of enjoyment to stay motivated, it is therefore recommended that the school should provide a computer-based math lab that helps the students to grasp the basic concept through gamification. It is also recommended that the mathematics teacher should be trained to teach the students of the 21st using technology-based education and step into the digital world of students.

7 Limitations and Directions for Future Studies

This study is solely based on the perception of the students and the instrument used to find the perception of the students about mathematics achievement through an online survey questionnaire, which limits the participation of students who have no internet facility. It is recommended that further researchers must also include a classroom test to validate the perception of students about mathematics after the survey is done. This double dip will allow the researchers to verify the perception of the students, especially those studying at a lower secondary level. Secondly, the perceptions of the construct of parental involvement were taken from students, however, it is ideal to involve parents as active participants in this study in order to get better results. It is recommended to interview parents about how they contribute and show involvement in school activities. Since Data were collected from Karachi (CBEK) schools and one private school therefore, it precludes the generalizability of the research findings. Besides, the nature of the cross-sectional data, the cause-and-effect may not be concluded.

References

1. Ailaan, A. (2017). Powering Pakistan for the 21st Century. (vol. II of III). The State of Maths and Science in Schools.
2. Ainley, J. (1999, July). Schools and the social development of young Australians: Frameworks, outcomes and influences. Paper presented at the National Social Outcomes of Schooling Forum organized by the Performance Measurement and Review Branch, Education Queensland, Surfers Paradise.
3. Anderson, L. W., & Bourke, S. F. (2000). Assessing affective characteristics in the schools (2nd ed.). Lawrence Erlbaum.
4. ASER. (2021). Annual Status of Education Report Pakistan National (Rural). SAFED.
5. Awofala, A. (2021). A validation of the mathematical resilience scale for twelfth graders through confirmatory factor analysis and its relationship with achievement in mathematics in Nigeria. SN Social Sciences. 1. 204. http://doi.org/10.1007/s43545-021-00212-8.
6. Awofala, A. O. & Lawani, A. O. (2020). Increasing mathematics achievement of senior secondary school students through differentiated instruction. Journal of Educational Sciences, 4(1), 1-19. https://doi.org/10.31258/jes.4.1.p.1-19
7. Awofala, A. O. (2017). Assessing senior secondary school students'

mathematical proficiency as related to gender and performance in mathematics in Nigeria. International Journal of Research in Education and Science, 3(2), 488-488. http://doi.org/10.21890/ijres.327908

8. Benner, Boyle, & Sadler. (2016). Parental Involvement and Adolescents' Educational Success: The Roles of Prior Achievement and Socioeconomic Status. Journal of Youth and Adolescence, 45(6), 1053-1064.
9. Bhavsar, N., Ntoumanis, N., Quested, E., Thøgersen-Ntoumani, C., & Chatzisarantis, N. (2020). Self-determination theory. The Routledge International Encyclopedia of Sport and Exercise Psychology, 565-583. Routledge.
10. Boonk, L. M., Gijselaers, H. J., Ritzen, H., & Brand-Gruwel, S. (2022). Student-perceived parental involvement as a predictor for academic motivation in vocational education and training (VET). Journal of Vocational Education & Training, 74(2), 187-209.
11. Bourke, S. F. (1993). Quality of life of primary and secondary students: Studies of classrooms and schools. In John S. Shellard (Ed.), New South Wales Institute for Educational Research Bulletin of Proceedings 1992 (pp. 71–77). New South Wales Institute for Educational Research.
12. Cai, J. (2003). Investigating parental roles in students' learning of mathematics from a cross-national perspective. Mathematics Education Research Journal, 15(2), 87–106.
13. Chen, M. P., Wang, L. C., Zou, D., Lin, S. Y., Xie, H., & Tsai, C. C. (2022). Effects of captions and English proficiency on learning effectiveness, motivation and attitude in augmented-reality-enhanced theme-based contextualized EFL learning. Computer Assisted Language Learning, 35(3), 381-411.
14. Deci, E. L., & Ryan, R. M. (2002). Self-determination research: Reflections and future directions. In E. L. Deci & R. M. Ryan (Eds.), Handbook of Self-determination Theory Research (pp. 431-441). University of Rochester Press.
15. Denscombe, M. (2010). The Good Research Guide for Small-Scale Social Research Projects (4th ed.). Butterworth-Heinemann.
16. Dorio, N. B., Clark, K. N., Demaray, M. K., & Doll, E. M. (2020). School climate counts: A longitudinal analysis of school climate and middle school bullying behaviors. International Journal of Bullying Prevention, 2(4), 292-308.
17. Epstein, J. (1992). School and family partnerships. In M. C. Alkin (Ed.), Encyclopedia of Educational Research (6th ed., pp. 1139–151). Macmillan.
18. Fan, X., & Chen, M. (2001). Parental Involvement and Student's Academic Achievement: A Meta-Analysis. Educational Psychology Review, 1-22.
19. Gagné, M., & Deci, E. L. (2014). The history of self-determination theory in psychology and management. In M. Gagné (Ed.), The Oxford handbook of work engagement, motivation, and self-determination theory (pp. 1–9). Oxford University Press.
20. Gefen , D., Straub, D. W., & Boudreau, M. C. (2000). Structural Equation Modeling and Regression: Guidelines for Research Practice, Communications for Association for Information System. 1-79.
21. Gomes, C. M., Fleith, D. D., Marinho-Araujo, C. M., & Rabelo, M. L. (2021). Predictors of students' mathematics

achievement in secondary education. Teoria e Pesquisa.
22. Grazia, V., & Molinari, L. (2021). School climate multidimensionality and measurement: A systematic literature review. Research Papers in Education, 36(5), 561-587.
23. Haenlein, M., & Kaplan, A. M. (2004). A beginner's guide to partial least squares analysis. Understanding statistics, 3(4), 283-297.
24. Hagenauer, G., & Hascher, T. (2010). Learning enjoyment in early adolescence. Educational Research and Evaluation, 16(6), 495-516.
25. Hair, J. F., Ringle, C. M. and Sarstedt, M. (2011). PLS-SEM: Indeed a Silver Bullet, Journal of Marketing Theory & Practice. 19(2), 139-152
26. Hair, J. F., Sarstedt, M., Hopkins, L., & Kuppelwieser, V. G. (2014). Partial least squares structural equation modeling (PLS-SEM): An emerging tool in business research. European Business Review.
27. Hair, Joseph & Ringle, Christian & Sarstedt, Marko. (2013). Partial Least Squares Structural Equation Modeling: Rigorous Applications, Better Results and Higher Acceptance. Long Range Planning. **46**. 1-12. http://doi.org/10.1016/j.lrp.2013.08.016.
28. Hammad, S., Graham, T., Dimitriadis, C., & Taylor, A. (2022). Effects of a successful mathematics classroom framework on students' mathematics self-efficacy, motivation, and achievement: a case study with freshmen students at a university foundation programme in Kuwait. International Journal of Mathematical Education in Science and Technology, 53(6), 1502-1527.
29. Hascher, T., & Hadjar, A. (2018). School alienation–Theoretical approaches and educational research. Educational Research, 60(2), 171-188.
30. Hattie, J. A. C. (2009). Visible learning: A synthesis of over 800 meta-analyses relating to achievement. Routledge
31. Headrick, L., Wiezel, A., Tarr, G. et al. Engagement and affect patterns in high school mathematics classrooms that exhibit spontaneous problem posing: an exploratory framework and study. Educational Studies in Mathematics **105**, 435–456 (2020). https://doi.org/10.1007/s10649-020-09996-7
32. Henseler, J., Ringle, C. M., & Sinkovics, R. R. (2009). The use of partial least squares path modeling in international marketing. New challenges to international marketing. Emerald Group Publishing Limited.
33. Henseler, J., Ringle, C.M & Sarstedt, M (2015) A new criterion for assessing discriminant validity in variance-based structural equation modeling. Journal of Academy and Marketing Science **43**, 115–135
34. Hill, F., Mammarella, I. C., Devine, A., Caviola, S., Passolunghi, M. C., & Szűcs, D. (2016). Maths anxiety in primary and secondary school students: Gender differences, developmental changes and anxiety specificity. Learning and individual differences, **48**, 45-53.
35. Hulin, C., Netemeyer, R., & Cudeck, R. (2001). Can a Reliability Coefficient Be Too High? Journal of Consumer Psychology, 10(1), 55-58. https://doi.org/10.1016/S2212-5671(15)00123-9
36. Jitin,K. (2015, April 14). Cognitive Evaluation Theory. https://www.slideshare.net/JitinKollamkudy/cognitive-evaluation-theory-46989022

37. Khawaja, R. (2018). Literacy rate in Pakistan. Lahore: The News.
38. Kirk, C. M., Lewis-Moss, R. K., Nilsen, C., & Colvin, D. (2011). The role of parent expectations on adolescent educational aspirations. Educational Studies, 37(1), 89–99.
39. Krapp, A. (2000). Interest and human development during adolescence: An educational-psychological approach. In J. Heckhausen (Ed.), Motivational psychology of human development: Developing motivation and motivating development (pp. 109–129). Elsevier Science. https://doi.org/10.1016/S0166-4115(00)80008-4
40. Lahaie, C. (2008). School readiness of children of immigrants: Does parental involvement play a role? Social Science Quarterly, 89(3), 684-705.
41. Lay, Y. F., Ng, K. T., & Chong, P. S. (2015). Analyzing affective factors related to eighth grade learners' science and mathematics achievement in TIMSS 2007. The Asia-Pacific Education Researcher, 24(1), 103–110.
42. Leonard, C., Bourke, S. F., & Schofield, N. (2002). Student quality of school life - A multilevel analysis. http://www.newcastle.edu.au/research-centre/sorti/people/sidbourke.html.
43. Levpušček, M. P., & Zupančič, M. (2009). Math achievement in early adolescence: The role of parental involvement, teachers' behavior, and students' motivational beliefs about math. Journal of Early Adolescence, 29(4), 541–570. https://doi.org/10.1177/0272431608324189
44. McLeod, D. B. (1992). Research on affect in mathematics education: A reconceptualisation. In D. A. Grouws (Ed.), Handbook of research on mathematics teaching and learning. Macmillan Publishing Company.
45. Middleton, J. A., & Spanias, P. A. (1999). Motivation for Achievement in Mathematics: Findings, Generalizations, and Criticism of the Research. Journal for Research in Mathematics Education, 65-88.
46. Neuman, W.L. (2007). Basics of Social Research Methods: Qualitative and Quantitative Approaches. (2nd ed.). Allyn and Bacon, Boston.
47. Nicolaidou, M., & Philippou, G. (2003). Attitudes towards mathematics, self-efficacy and achievement in problem solving. European Research in Mathematics Education III. Pisa: University of Pisa, 1-11. Retrieved from http://www.dm.unipi.it/~didattica/CERME3/proceedings/Groups/TG2/TG2_nicolaidou_ cerme3.pdf
48. Nilsen, T., & Teig, N. (2022). A systematic review of studies investigating the relationships between school climate and student outcomes in TIMSS, PISA, and PIRLS. In T. Nilsen, A. Stancel-Piątak, & J. E. Gustafsson (Eds.), International handbook of comparative large-scale studies in education. Springer International Handbooks of Education.
49. Nilsen, T., Kaarstein, H., & Lehre, A. C. (2022). Trend analyses of TIMSS 2015 and 2019: school factors related to declining performance in mathematics. Large-scale Assessments in Education, 10(1), 1-19.
50. Pekrun, R. (2006). The control-value theory of achievement emotions: Assumptions, corollaries, and implications for educational research and practice. Educational Psychology Review, 18(4), 315-341.
51. Pekrun, R. (2017). Emotion and achievement during

adolescence. Child Development Perspectives, 11(3), 215-221.

52. Phillipson, S., & Phillipson, S. N. (2012). Children's cognitive ability and their academic achievement: The mediation effects of parental expectations. Asia Pacific Education Review, **13**, 495–508. https://doi.org/10.1007/s12564-011-9198-1
53. Prior, J., & Gerard, M. R. (2007). Family involvement in early childhood education: Research into practice. Thomson.
54. Sandra, John & Gavin. (2013). Factors Influencing Early Adolescents' Maths Achievement: High Quality Teaching Rather than Relationships. Learning Environments Research. **16**. 49-69. http://doi.org/10.1007/s10984-012-9106-6.
55. SAT. (2016). SAT IV. Education and Literacy Department, Govt. of Sindh.
56. Schleicher, A. (2002, April). First results from PISA. Paper presented at the Annual Meeting of the American Educational Research Association, New Orleans, USA
57. Simegn, E. M., & Asfaw, Z. G. (2017). Assessing the Influence of Attitude Towards Mathematics on Achievement of Grade 10 and 12 Female Students in Comparison with Their Male Counterparts: Wolkite, Ethiopia. International Journal of Secondary Education, 5(5), 56-69.
58. Tekin, A. K. (2011). Parent involvement revisited: Background, theories, and models. International Journal of Applied Educational Studies, 11(1), 1-13.
59. Teressa, T. D., & Bekele, G. (2021). Motivational Predictors of Tenth Graders' Academic Achievement in Harari Secondary Schools. International Journal of Education and Literacy Studies, 9(3), 9-19.
60. Vierhaus, M., Lohaus, A., & Wild, E. (2016). The development of achievement emotions and coping/emotion regulation from primary to secondary school. Learning and Instruction, **42**, 12-21.
61. Wang, G., Zhang, S. & Cai, J. How are parental expectations related to students' beliefs and their perceived achievement?. Educ Stud Math **108**, 429–450 (2021). https://doi.org/10.1007/s10649-021-10073-w
62. Wang, M. T., & Degol, J. L. (2016). School climate: A review of the construct, measurement, and impact on student outcomes. Educational Psychology Review, 28(2), 315-352.
63. Wigfield, A., Eccles, J. S., Schiefele, U., Roeser, R., Davis-Kean, P. (2006). Motivation. In N. Eisenberg (Ed.), Handbook of child psychology, Vol. 3 (6th ed.). Hoboken, NJ: John Wiley & Sons.
64. Yılmaz, Ç., Altun, S. A., & Olkun, S. (2010). Factors affecting students' attitude towards Math: ABC theory and its reflection on practice. Procedia-Social and Behavioral Sciences, 2(2), 4502-4506.
65. Yu, R., & Singh, K. (2018). Teacher support, instructional practices, student motivation, and mathematics achievement in high school. The Journal of Educational Research, 81-94.
66. Zan, R., & Martino, P. D. (2007). Attitude towards mathematics: Overcoming positive/negative dichotomy. In S. Bharath , The Montana Mathematics Enthusiasts Monograph (pp. 157-168). The Montana Council of Teacher of Mathematics.