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Students' Self-Efficacy in Mathematics Academic Achievement: Do Teachers' Personality Traits Matter?

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ABSTRACT

Students' academic achievement is influenced by a wide range of factors, ranging from individual, family-related, school-related, and societal factors. The current study explores the effect of students' self-efficacy (SSEF) on math academic achievement among secondary students, with a specific focus on the potential moderating role of teachers' personality traits (TPTS). To achieve the study objective, an epistemological-positivist research paradigm and cross-sectional research design were used to guide the study. Confirmatory factor analysis (CFA) and PROCESS macro were employed for data analysis. The results reveal a significant and positive correlation between SSEF beliefs and their math academic achievement (β = 0.4525, p = 0.0000). Moreover, the results demonstrate that the effect of SSEF on math academic achievement is significantly increasing at the increased level of TPTS (β = 0.0572, p = 0.0089), affirming the crucial role of TPTS in shaping SSEF and math academic endeavours. These findings hold relevant for educators, schools' administrators, and policymakers. Among others, the study recommends the need to design and implement training programs, workshops, seminars and offer teaching tools that nurture and cultivate SSEF, self-esteem, and TPTS in shaping students' trajectories of math success. This study unravels the intricate interplay between self-efficacy, TPTS, and secondary students' achievements in the realm of mathematics. By so doing, the study contributes to both theoretical knowledge and practical insights, offering a deeper understanding of the complex factors influencing academic success in math among secondary students.

Keywords: *Self-efficacy; secondary students; teachers' personality traits; math academic achievement.*

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1. INTRODUCTION

Academic achievement is a multi-faceted endeavour involving academic performance, personal growth, and preparation for the next stages of life. Academic achievement not only impacts a student's overall academic performance but also holds significant consequences for their future educational and career prospects. In the realm of education, achieving academic excellence encompasses grasping complex concepts, employing critical thinking skills, and applying acquired knowledge to real-world situations (Kihwele and Mkomwa, 2023; Tsai and Antoniou, 2021; Williams et al., 2016). It denotes the extent of a student's accomplishments in their educational pursuits, which are gauged through diverse metrics such as grades, standardized test scores, involvement in extracurricular activities, participation in research projects, and their overall engagement in the learning process (Hinnant-Crawford et al., 2016; Tayyaba, 2010). Understanding the determinants that influence a student's academic achievement is of utmost significance for educators, policymakers, and researchers striving to improve educational outcomes and foster career development. Previous research has revealed that factors including cognitive

abilities, instructional methodologies, and socioeconomic backgrounds exert an influence on students' academic performance and attainment (Gopal et al., 2020; Dennis, 2022; Saadat and Sultana, 2023).

Among others, Hinnant-Crawford et al. (2016), Jamil and Mahmu (2019) and Deepa (2005) found and reported combined students' efforts such as effective study habits, time management skills, self-organisation, taking effective notes as the cognitive abilities that contribute to better students' academic performance. Besides that, studies by Moldasheva and Mahmood (2014) and Tevfik and Güler (2021) ascertained that participating in extracurricular activities, such as sports, arts, clubs, and community service, can contribute to a well-rounded education and positively impact students' academic achievement. This is due to the fact that extracurriculars provide an outlet for students to unwind and reduce stress, build relationships, and work in teams, the attributes which are valuable assets for academic and professional pursuits. Other studies by Arens and Frenzel (2020) and Kyaruzi (2023) found social dynamics such as supportive parents and teachers, positive peer relationships, up-to-date textbooks, technology and well-designed curriculum as the key determinants of academic outcomes among students. On the contrary, school jobs or family responsibilities can impact the time and energy available for academic pursuits, thus negatively impacting students' academic performance (Berkovich and Eyal, 2019; Opstad, 2018; Kaur et al., 2004). Hence, as academic demands increase, students need to develop strong time management skills to balance coursework, extracurricular activities, and personal responsibilities towards enhanced academic achievement.

Among these factors, one psychological construct that has gained considerable attention in the context of students' academic achievement is self-efficacy. Self-efficacy, a construct introduced and renowned by psychologist Albert Bandura, emphasizes the role of cognitive processes, self-regulation, and environmental factors in shaping human behaviour (Bandura, 2012; Wood and Bandura, 1989). It is considered a critical determinant of students' motivation, learning strategies, and ultimately, their academic achievement. Self-efficacy, in particular, refers to an individual's belief in their ability to successfully perform a specific task or achieve a particular goal (Bandura, 2012; Bandura, 1997). Self-efficacy beliefs influence how individuals approach challenges, persist in the face of difficulties, and recover from setbacks. Studies have shown that higher levels of self-efficacy are associated with increased effort, persistence, and engagement in learning activities (Kyaruzi, 2023; Arens and Frenzel, 2020; Yokoyama, 2019). In an educational context, students with higher self-efficacy are more likely to set ambitious goals, engage in active learning, and persevere when encountering academic hurdles, ultimately leading to improved academic achievement. Conversely, students with low self-efficacy may experience diminished motivation, reduced effort, and negative attitudes, impeding their academic achievement (Alhadabi and Karpinski, 2020; Warren et al., 2021; Deepa, 2005).

Apart from self-efficacy beliefs, literature regard teachers as the pivotal figures in shaping students' educational experiences (Berkovich and Eyal, 2019; Rezaei et al., 2019; Zadok and Benoliel, 2023). Teachers' personalities encompass a range of individual attributes, behavioural patterns, and attitudes that shape their instructional approaches, classroom climate, and interactions with students. Their teaching methods, interpersonal interactions, and individual characteristics contribute to the classroom climate and students' perceptions of their own capabilities. Traits such as extraversion, agreeableness, conscientiousness, openness, and emotional stability not only define teachers' interpersonal styles but also potentially affect students' perceptions of their own abilities (Berkovich and Eyal 2019; Kessler et al., 2019; Aarti and Kadian, 2022). Although every student is unique, and factors such as learning disabilities, health issues, and personal circumstances can affect academic achievement, tailoring educational approaches to individual needs is important. It has been revealed that teachers who create an inclusive

and stimulating supportive learning classroom environment often inspire students to perform at their best (Agyemang et al., 2016; Shaninah and Noor, 2023; Zadok and Benoliel, 2023).

Studies addressing the impact of students' self-efficacy (SSEF) and teachers' personality traits (TPTS) on math academic achievement (MATH) among Tanzania's secondary school students are indeed limited. Notable exceptions include Kyaruzi (2023), Kihwele and Mkomwa (2023) and Kyaruzi (2019), all of which, however, employed descriptive analysis. Similar studies are widely acknowledged in middle schools (Zadok and Benoliel, 2023; Hinnant-Crawford et al., 2016; Tayyaba, 2010) and higher learning institutions (Yokoyama, 2019; Alhadabi and Karpinski, 2020; Aarti and Kadian, 2022) on a global scale. The novelty of this study lies in applying social cognitive theory to understand the interplay between SSEF, TPTS, and MATH among secondary schools in Tanzania, using confirmatory factor analysis (CFA) and the Hayes PROCESS macro. The potential interplay between these factors remains a relatively unexplored dimension. Efficient educational approaches and support structures consider these elements essential for assisting students in reaching their full academic capabilities. Nevertheless, it is crucial to acknowledge that these elements interact with one another, and their impacts may fluctuate depending on an individual's specific circumstances. This research endeavours to fill this gap by investigating whether TPTS interact with SSEF beliefs in shaping academic performance in mathematics among secondary school students. To achieve the study objective, the study sought to address the following research questions:

RQ1. Does SSEF in math relates to their academic achievement in the subject?

RQ2. Can TPTS moderates the relationship between SSEF and math academic achievement?

This research offers significant implications for educational policymakers, school administrators, and teacher training programs. They can utilize the findings of this study to create approaches that foster constructive teacher-student interactions, boost self-efficacy beliefs, and, in turn, elevate the academic performance in mathematics for secondary school students. Moreover, the findings from this research contribute to the existing body of knowledge by shedding light on the importance of teachers' personality traits in fostering students' self-efficacy in mathematics.

2. THEORETICAL FRAMEWORK AND HYPOTHESES DEVELOPMENT

The social cognitive theory (SCT)

The study employed SCT as a suitable theoretical framework to investigate the influence of SSEF, TPTS, and math academic achievement, similar to previous studies (Alhadabi and Karpinski, 2020; Yokoyama, 2019; Rubenstein et al., 2018; Lent et al., 2018). SCT highlights the importance of observational learning, self-efficacy and self-regulation, in shaping human behavior and development. It posits that human behaviour is influenced by the dynamic interplay of personal factors (cognition, emotions, personality), behaviour patterns, and environmental factors (societal norms, social influences) (Wood and Bandura, 1989; Bandura, 2012). In addition, SCT highlights the role of self-efficacy, which refers to an individual's belief in their ability to accomplish a specific task or goal (Bandura, 1997).

In this research, SCT serves as a valuable and extensive theoretical framework for investigating how TPTS (social influences) moderate the relationship between SSEF (individual factors) and academic success in mathematics among secondary school students. More importantly, the theory facilitates our understanding of how students' beliefs about their mathematical abilities (self-efficacy) affect their performance in mathematics. It is theorized that students with higher self-efficacy are more likely to set challenging goals, invest effort, and persist through challenges, ultimately leading to enhanced math academic achievement (Lent et al., 2018; Rubenstein et al., 2018). Moreover, it suggests that students learn from observing others, particularly their teachers. Hence, teachers, being crucial social models for students, can significantly influence SSEF beliefs (Tsai and Antoniou, 2021; Zadok and Benoliel, 2023). In

this case, SCT's concepts offer valuable insights into how TPTS can impact students' beliefs and academic outcomes in the context of mathematics education.

Math academic achievements

Math academic achievement encompasses a wide of cognitive skills, knowledge, problem-solving abilities, and the application of mathematical theories, principles, and concepts to real-world contexts, which goes beyond rote memorization (Kessler et al., 2019; Opstad, 2018). It reflects a student's competence and proficiency in mathematical operations, including arithmetic, algebraic manipulation, and geometry. Within an educational context, math academic achievement is typically assessed through various means, such as grades and scores earned from tests, exams, assignments, projects, and classroom participation. Studies assert that grades and scores above average, aligned with a student's goals, signify the attainment of math achievement (Tayyaba, 2010; Williams et al., 2016). Furthermore, the ability to solve complex mathematical problems, interpret, and analyse mathematical information presented in diverse formats such as graphs, charts, tables, and written explanations constitutes a significant aspect of math academic achievement (Zientek et al., 2019; Opstad, 2018). Principally, proficient math students engage in critical thinking, logical reasoning, and creative strategies to tackle a variety of mathematical challenges. Additionally, Bezzina (2010) noted that the capability to perform accurate and efficient calculations, as well as completing math assignments and tasks in time, is a foundational skill of math achievement. Challenges can arise from individual students, learning environments, teaching methods, and societal influences that hinder math academic achievement among secondary students. These include math anxiety, the unique needs of individual students, gaps in foundational math concepts, and learning environments that do not foster supportive, collaborative teaching methods (Abidin et al., 2018; Asad et al., 2022). Furthermore, the endeavour to balance academic demands with other commitments, such as socio-economic activities at home, can result in insufficient time for studying and practising math (Dennis, 2022; Lent et al., 2018).

Development of hypotheses

In the context of mathematical education, studies reveal that SSEF plays a significant role in enhancing math academic performance and achievement (Hinnant-Crawford et al., 2016; Saadat and Sultana, 2023; Zientek et al., 2019). It has been reported that high levels of self-efficacy contribute to motivation, effort, and persistence in pursuing tasks, even in the face of challenges or setbacks, all of which contribute to better performance in math-related tasks. Conversely, students who doubt their own mathematical abilities struggle with confidence and motivation, leading to avoidance of challenging math activities and poor academic performance (Zientek et al., 2019; Warren et al., 2021). When facing challenging math problems or concepts, students with high levels of self-efficacy are less likely to give up, instead, they approach it with confidence and enthusiasm, viewing it as opportunities to learn and grow (Aarti and Kadian, 2022; Cheung et al., 2023). These resilience and positive attitudes lead to better study habits, more active engagement in class, and a willingness to tackle complex math problems. Furthermore, students with higher self-efficacy set ambitious goals and are more willing and confident in their ability to explain mathematical concepts to others, which in turn reinforces their belief in their abilities. Consequently, their efforts translate to improved performance on assignments, tests, and exams. Therefore, it is hypothesized that:

H1. SSEF is positively associated with MATH.

Moderating role of teachers' personality traits

Literature establishes that certain TPTS can either enhance or diminish the impact of SSEF on math performance (Agyemang et al., 2016; Ahmed et al., 2019; Aarti and Kadian, 2022). TPTS play a significant

role in shaping the learning environment, interactions with students, and overall classroom dynamics. For instance, teachers possessing personality traits such as warmth, empathy, and enthusiasm can strengthen the relationship between SSEF and math performance (Berkovich and Eyal, 2019). Enthusiastic teachers make lessons more engaging and inspire students to develop a deeper appreciation for the subject, while also fostering a comfortable atmosphere for asking questions and seeking help. When students believe in their own abilities (self-efficacy) and encounter teachers who provide support and encouragement, the combined effect can lead to increased motivation, engagement, and perseverance (Maamari and Salloum, 2023). Furthermore, teachers with strong organizational skills, high expectations for student performance, and adaptability in their teaching approaches could potentially amplify the link between SSEF and math performance (Rezaei et al., 2019). These teachers may adjust their methods to align with students' individual learning styles and needs, managing classroom routines, assignments, and assessments more effectively. Conversely, teachers lacking supportive traits or exhibiting negative behaviours might weaken the relationship between SSEF and math performance (Aarti and Kadian, 2022; Maamari and Salloum, 2023). If students with strong self-efficacy do not receive encouragement or experience a lack of understanding from their teachers, their motivation and engagement may suffer, thereby diminishing the positive effect on math performance. In view of these arguments, the study hypothesizes that:

H2. TPTS moderates the relationship between SSEF and MATH

Conceptual model

Figure 1 is a conceptual model outlining the relationships between SSEF, TPTS and math academic achievement among secondary students. The conceptual model provides a framework for understanding how TPTS influence the connection between SSEF and their math academic achievement. The model postulates that SSEF is significantly associated with math academic achievement. In addition, TPTS moderate the relationship between SSEF and math academic achievement.

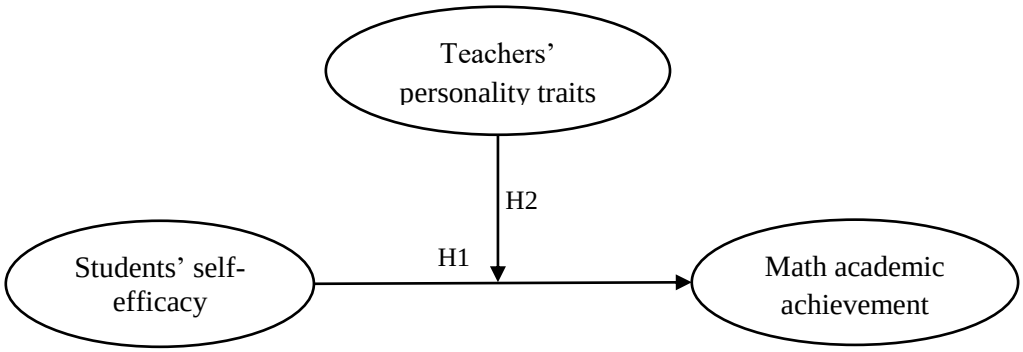


Figure 1. Proposed conceptual model

3. METHOD

Research paradigm and design

An epistemological-positivist research paradigm was utilized for this study. Epistemological positivism is particularly influential when researchers aim to confirm or reject hypotheses based on quantifiable and measurable numerical data (Eichelberger, 1989). In the context of this study, the author sought to establish causal relationships, test hypotheses between variables under investigation, and make inferences about the broader population using quantifiable empirical data. To achieve the study objectives, a cross-sectional research design was used to gain insights and provide snapshots of characteristics and relationships within a population or sample at a particular time frame. In this case, data were collected from a population or sample at a single point in time (Saunders et al., 2019).

Data collection and sampling

This study concentrates specifically on ordinary-level secondary students (typically ages 13 to 18), from 32 government-owned secondary schools in Temeke District, Tanzania. The list of schools was obtained from the district administrative secretary for the 2022/2023 academic year. According to the Tanzanian education landscape, the secondary education system is divided into two essential components: ordinary secondary education, which spans 4 years (from Form I to Form IV), and advanced secondary education, which lasts 2 years (Form V and Form VI). Ordinary secondary education is a critical stage in a student's academic journey where the foundations for future success are often laid, with more in-depth study of mathematics as a core subject. The selection of the study area was based on the district's high potential for having a significant number of secondary schools compared to other districts (United Republic of Tanzania (URT), 2022). Additionally, the district was chosen due to its relatively high concentration of ordinary secondary students. To ensure representation of students from each school, simple random sampling was employed. Within each school, students were selected proportionally to participate in the study, resulting in a sample size of 578. However, only 549 responses, equivalent to 94.98%, were considered useful and included in the analysis.

A structured questionnaire survey was used to collect data on the study variables through a researcher-administered approach over a six-month period from November 2022 to April 2023. This approach allowed the researcher to read the questions directly to the respondents, clarify any doubts, and let them record their responses. Moreover, questionnaire survey was selected because of its ability to prevent any potential bias thereby covering a wide area and providing a large amount of information in a short period of time (Saunders et al., 2019). Ethical considerations were addressed by obtaining informed consent from teachers and parents, enabling the researcher to collect data from students, the majority of whom were below the age of 18 years.

Measurements, reliability, and validity

The questionnaire items used in this study were adapted from previous studies. The seven items for SSEF were adopted from validated scales developed by Hinnant-Crawford et al. (2016), Saadat and Sultana (2023), and Zientek et al. (2019). TPTS was measured using nine items adopted from Agyemang et al. (2016), Ahmed et al. (2019), Aarti and Kadian (2022), and Berkovich and Eyal (2019). Similarly, the five items for MATH were based on measurement scales from Kessler et al. (2019), Opstad (2018), and Zientek et al. (2019). A five-point Likert scale ranging from "1 = strongly disagree" to "5 = strongly agree" was used to assess participants' levels of self-efficacy and their teachers' personality traits. For the MATH construct, the researcher gathered students' academic records in mathematics over a specific time frame. These records were coded into a five-point Likert scale: 1 = very poor (0-29), 2 = poor (30-44), 3 = average (45-64), 4 = good (65-74), and 5 = very good (75-100). This coding provided quantitative indicators of academic performance, as used in Tanzania's education grading system. To ensure clarity in response options and account for other factors that could impact reliability and validity, consultation was sought from experts in the field. The experts reviewed the items for relevance and appropriateness, and their feedback was appropriately incorporated.

Composite reliability (CR) and Cronbach's alpha (α) were employed to assess the internal reliability of items within each scale through confirmatory factor analysis (CFA). This assessment ensures that the items within a scale measure the same underlying construct (Barati et al., 2019; Israel, 2023). For assurance of internal reliability of the research instrument, Cronbach's Alpha and CR cutoff of 0.7 is recommended (Hair et al., 2020). As shown in Table 1, each construct achieved Cronbach's Alpha and CR values above 0.7. Convergent validity of the measurement scale was also evaluated using factor loading and average variance extracted (AVE). All three constructs were reflective in nature, with factor loadings showing

satisfactory values lying above 0.6 and AVE values greater than 0.5, thus suggesting the establishment of convergent validity (Hair et al., 2020). Furthermore, the Fornell-Larcker criteria were employed to assess the proposed model's discriminant validity (Hair et al., 2020). Table 2 demonstrates the validation of the model's discriminant validity, as the square root of AVE for each construct (bold italicized values) exceeds the inter-construct correlation in each column (Fornell and Larcker, 1981). These results ensure the adequacy of the dataset for further inferential analysis.

Table 1. Measurement items and CFA results

Constructs/items	λ	α	CR	AVE
Students' self-efficacy (SSEF)		0.817	0.921	0.630
SSEF1. I am confident in my ability to solve complex math problems	0.960			
SSEF2. I believe that if I work hard, I can improve my math skills	0.809			
SSEF3. I feel capable of understanding complex mathematical concepts	0.740			
SSEF4. I am certain that I can perform well on math tests and exams	0.686			
SSEF5. I am confident that I can overcome difficulties in learning math	0.682			
SSEF6. I am confident that I can explain mathematical ideas to others	0.917			
SSEF7. I am certain I can figure out solutions to unfamiliar math problems	0.716			
Teachers' personality traits (TPTS)		0.796	0.904	0.516
TPTS1. My math teacher is approachable and easy to talk to	0.741			
TPTS2. My math teacher is organized and plans the lessons well	0.800			
TPTS3. My math teacher is enthusiastic and passionate about teaching math	0.790			
TPTS4. My math teacher is well-organized and provides clear instructions	0.810			
TPTS5. My math teacher is open to different viewpoints and encourages class discussions	0.795			
TPTS6. My math teacher is supportive/offers guidance to help me improve	0.602			
TPTS7. My math teacher is respectful and treats students fairly	0.648			
TPTS8. My math teacher is adaptable and uses various teaching methods	0.609			
TPTS9. My math teacher is confident and knowledgeable in the subject	0.632			
Mathematical Academic Achievements (MATH)		0.845	0.897	0.636
MATH1. Current math grades	0.699			
MATH2. Average score earned on last math exam	0.838			
MATH3. Total points on last math assignments	0.898			
MATH4. Average scores on last math quiz and tests	0.750			
MATH5. Overall math grade for the last semester	0.787			

Table 2. Discriminant validity (Fornell-Larcker criterion)

	CR	AVE	MSV	ASV	MATH	TPTS	SSEF
MATH	0.897	0.636	0.333	0.231	***0.797***		
TPTS	0.904	0.516	0.192	0.160	0.359	***0.719***	
SSEF	0.921	0.630	0.333	0.262	0.577	0.438	***0.794***

Common-method variance (CMV)

The evaluation of CVM was carried out in order to address the potential limitation arising from the self-reported nature of survey data and the likelihood of response bias. Harman's (1967) single-factor test was utilized for this purpose. All items were subjected to factor analysis with the unrotated factor option, aiming to ascertain whether a predominant portion of the variance could be accounted for by a single factor, as suggested by Podsakoff et al. (2003). The findings from the analysis indicate that approximately 37.68% of the overall variance explained within the model could be attributed to a sole factor. Since this

percentage falls below the 50% threshold, it can be concluded that common method bias did not significantly impact the study.

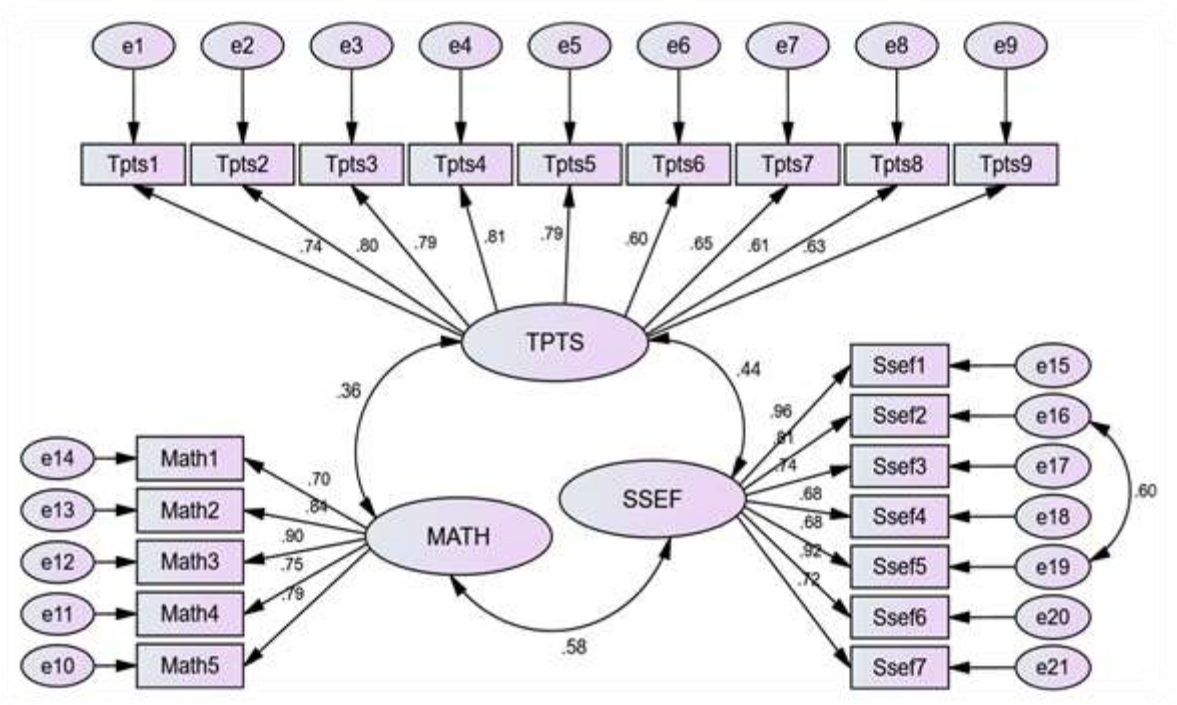
Data analysis

Confirmatory factor analysis (CFA) was carried out to ascertain the extent to which the collected data aligns with the measurement model for fit indices, reliability measures, and validity assessments. As highlighted by Barati et al. (2019), CFA plays a crucial role in evaluating the accuracy of the measured items for latent variables in multivariate analysis. Following the establishment of the measurement model's validity and reliability, the 'PROCESS macro' was employed to examine how TPTS moderates the relationships between SSEF and MATH. PROCESS macro offers a robust and contemporary solution for conducting regression analysis with supplementary variables such as moderators, mediators, and covariates (Hayes, 2022).

4. RESULTS AND DISCUSSION

The model fit results

Table 1 and Figure 2 present the results of CFA which was performed to determine whether the measurement model fits well the data collected. At the outset, the measurement model did not align with the data as the values of $\chi 2/df$ = 5.6533 which was greater than the recommended value of 3.0 ≤, and degree of freedom (df) = 185 at p = 0.1052 < 0.01 was obtained. Other model fit indices, including goodness of fit index (GFI), incremental fit index (IFI), normed fit index (NFI), relative fit index (RFI), comparative fit index (CFI), Tucker–Lewis index (TLI), root mean square error of approximation (RMSEA), standardized root mean square residual (SRMR), and Pclose were all within the recommended ranges. In order to enhance the model, covariance of error terms based on modification indices (MI > 30) was introduced. The revised measurement model demonstrated good fit indices, proving that the model accurately fits the data. Figure 2 contains the fit indices for the revised model.



Model fit indices: $\chi 2/df$ =3.296; GFI = 0.865; NFI = 0.911; RFI = 0.932; TLI = 0.954; IFI = 0.946; CFI = 0.964; RMSEA = 0.065; SRMR = 0.039; PCLOSE = 0.127.

Figure 2. Measurement model

Hypotheses testing and discussion

The PROCESS macro v.4.2, a robust tool for analysing direct, moderation and indirect effects was used to test the study hypotheses among the study of variables. Table 3 presents the results of the moderating role of TPTS on the relationship between SSEF and MATH. The study results indicate that the variables in the model contribute approximately to about 30.64% of the variance of MATH (R^2 = 0.3064, F = 39.7591, and p = 0.0000 < 0.05). To begin, the study hypothesized that *"H1: SSEF is positively associated with MATH"*. Looking at Table 3, the results reveal that the direct effect of SSEF at a mean of TPTS is positive and statistically related to MATH (β = 0.4525, p = 0.0000, with confidence intervals ranging between 0.3302 and 0.5747. These results are consistent with H1, implying that SSEF is a key predictor of math academic achievement for secondary school students. These findings are consistent with those of Hinnant-Crawford et al. (2016) and Deepa (2005), who examined the effect of self-efficacy on mathematics achievement among middle school students in the USA and Auckland. In their study, they opined that students with a high level of self-efficacy in math are more likely to be self-motivated and perform better in the subject. This is qualified to the fact that high self-efficacy fosters resilience, goal-setting behaviours, and emotional well-being in approaching complex assignments, thereby contributing to a deeper understanding of mathematical concepts and overall achievements. These arguments concur with the study findings of Tevfik and Güler (2021) and Gopal et al. (2020) on student's self-efficacy and maths academic achievement among secondary students in Malaysia and Turkey who opined that SSEF fosters resilience and willingness in tackling complex maths problems, which is an important attribute of academic achievement.

Furthermore, the results in Table 3 present the effect of TPTS on MATH at the mean of the predictor variable (SSEF). Results demonstrate that the effect of TPTS on MATH at the mean of SSEF is positive and significantly significant (β = 0.1728, p = 0.001) and confidence intervals ranging from 0.0698 to 0.2727. This result implies that math academic achievement among secondary students is significantly increasing at the increased level of TPTS. These findings are supported by those of Kim et al. (2018), Arthur et al. (2022) and Gulistan et al. (2017) who also revealed a positive and significant impact of TPTS in supporting secondary school students' self-efficacy and maths achievement in Australia, Ghana and India. In particular, these studies emphasise that teachers who are open to different viewpoints, encourage discussions, offer clear instructions, provide well-organised lesson plans, and are confident and knowledgeable in the subject create a safe space for students to succeed in math endeavours. Moreover, similar studies by Tsai and Antoniou (2021) and Kyaruzi (2019) asserted that TPTS play a crucial role in providing constructive feedback and helping students in building a strong foundation of math skills, thereby building confidence towards enhanced math academic achievement.

Table 3. Regressions results on the relationships between study variables

Variables	Coefficient	Se	T	P	LLCI	ULCI
Constant	3.7793	0.0344	109.9487	0.0000	3.7116	3.8469
SSEF	0.4525	0.0621	7.2891	0.0000	0.3302	0.5747
TPTS	0.1728	0.0523	3.3035	0.0011	0.0698	0.2757
Int_1 (SSEF*TPTS)	0.0572	0.0662	0.8630	0.0089	0.0732	0.1876
R^2	0.3064					
F(sig.)	39.7591			0.000		
R^2 change	0.0589					
F(sig.)	4.4653			0.0089		

Testing the moderation effect

The study also put forth the hypothesis that "*H2: TPTS moderates the relationship between SSEF and MATH*". Analysing the results presented in Table 3, it becomes apparent that the interaction term (SSEF*TPTS) exhibited a positive and statistically significant association with MATH (β = 0.0572, p = 0.0089), with confidence intervals ranging from 0.0732 to 0.1876. As there are no zero values within the intervals, the results indicate that TPTS serves as a positive and significant moderator in the relationship between SSEF and MATH, thereby providing support for H2. The findings also demonstrate a noteworthy alteration (approximately 5.89%) in the variance of MATH attributable to the interaction variable (R^2 change = 0.0589, F = 4.4653, and p = 0.0089). Additionally, slope plotting was carried out to illustrate the moderating effect of TPTS on the impact of SSEF on MATH at three different conditioning values: one standard deviation above the mean (+0.69), the mean (0.0), and one standard deviation below the mean (-0.69) of the moderating variable (TPTS). In summary, the results presented in Figure 3 illustrate that TPTS enhances the positive relationship between SSEF and MATH. Consequently, when TPTS is at a high level (standard deviation = 0.69), the influence of SSEF on MATH is more pronounced compared to when TPTS is at a low level (standard deviation = -0.69).

In the context of this study, the results demonstrate that TPTS play a positive and significant role in shaping students' attitudes, behaviours, and ultimately their performance in math. These findings are consistence with SCT which emphasises the role of societal influences on individual behaviours and observational outcomes (Bandura, 2012; Wood and Bandura, 1989). Since students interact with teachers in their learning process, the study findings validate that this interaction enhances SSEF and math academic achievement. In line with these findings, studies by Tayyaba (2010), Abidin et al. (2018) revealed a positive a significant role of teachers' personality traits in fostering students' self-efficacy and maths academic achievement among middle school students in Pakistan and Indonesia. According to their findings, students with high levels of self-efficacy are more likely to improve in MATH through TPTS. These arguments are supported by the fact that a positive and supportive teacher-student relationship, coupled with effective and adaptable teaching strategies, enthusiasm, and warmth can lead to enhanced learning outcomes and a deeper appreciation for the subject. These, in turn, inspire students to approach math challenges with confidence, hence building resilience in math academic performance and achievement as was also found and reported by Arthur et al. (2022), Dennis (2022) and Frank (2018).

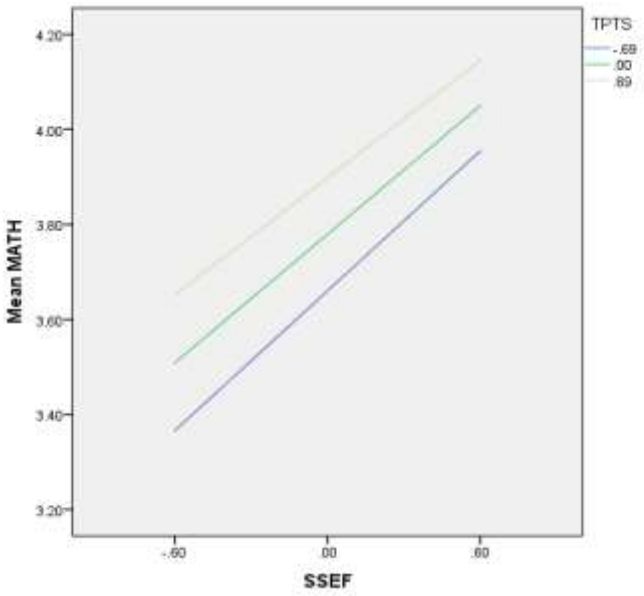


Figure 3. Slope plotting for the interaction effect (SSEF*TPTS)

5. CONCLUSION

This research has delved into a critical juncture of students' success—the influence of self-efficacy and the potential role of TPTS on math academic achievement among secondary students. Through an exploration of these intertwined factors, a comprehensive understanding of the educational landscape has been illuminated. The findings of this study clearly affirm the central role that self-efficacy beliefs play in shaping students' math academic achievement. The findings demonstrate that students who possess higher levels of self-efficacy tend to perform better in mathematics academic journeys. Moreover, the study introduces an innovative dimension by investigating the influence of TPTS on SSEF and math academic achievement. The results unveil a significant and positive moderation role of TPTS—such as enthusiasm, empathy, support, warmth, and adaptability on SSEF and math academic achievement, indicating that the effect of SSEF on math academic achievement is significantly increasing at the increased level of TPTS. Therefore, teachers who exhibit positive personality traits create an environment where students feel supported, capable, and motivated, which, in turn, reflects positively on their math academic achievement. Ultimately, the study concludes that the pursuit of students in math academic achievement is a multifaceted and consequential dynamic. It rests not only on the foundation of subject mastery, but also on the pillars of self-belief, guidance, and encouragement that educators can provide.

Study implications

1. Theoretical relevance

While previous studies have separately examined the direct effect of SSEF (Alhadabi and Karpinski, 2020; Bezzina, 2010; Saadat and Sultana, 2023; Yokoyama, 2019) and TPTS (Berkovich and Eyal, 2019; Rezaei et al., 2019) on students' academic outcomes, this research bridges these domains. It extends from previous studies and explores the intricate interplay between SSEF beliefs and the personality traits exhibited by their teachers, offering a unique perspective on SCT in learning mathematics among secondary students and their academic endeavours. Overall, the findings of this study provide empirical support for the validation of Bandura's SCT in understanding the role of self-efficacy beliefs and social influences in influencing human behaviour and achievement (Wood and Bandura, 1989; Bandura, 1997). In particular, the study findings suggest that the potential intersection between SSEF and TPTS enables a more comprehensive mathematical academic achievement among secondary school students. These findings reinforce the assumptions of SCT, by demonstrating the significant impact of SSEF and TPTS on math academic achievement. This validation strengthens the broader application of the theory in understanding various domains of human behaviour, achievement and accomplishments. Like previous studies (Tsai and Antoniou, 2021; Warren et al., 2021; Yokoyama S (2019), the current study underscores that the interplay between SSEF and TPTS creates a more robust learning environment in shaping students' academic achievement.

2. Practical implications

Beyond theoretical contributions, the study has practical implications for teachers and school administrators. To school administrators, the study recommends the need to design and implement programs that enhance students' self-efficacy and self-esteem. These may include infusing workshops, seminars, and activities that focus on building confidence, problem-solving skills, and perseverance in the face of complex math challenges among students. By so doing, students develop a growth mindset, fostering the belief that effort and practice lead to improvement, ultimately boosting their math academic achievement. Moreover, school administrators and educational policymakers can consider incorporating teacher training programs that focus on enhancing personality traits that positively impact student outcomes. Offering teachers tools and workshops to cultivate traits such as patience, teaching methods, communication skills, encouragement, adaptability, and teacher-student relationships can create a more

supportive and conducive learning environment for students. In addition to that, emphasizing collaborative planning, discussions and sharing of experience among teachers can create a more consistent and supportive learning experience for students in math subject and classrooms.

Limitations and Directions For Future Research

Despite the fact that this study achieved its objectives in terms of geographical context and the level of academic achievement in which it was conducted, it still establishes some limitations and interesting results for future studies. Firstly, the use of cross-sectional research design limits the ability to establish causal relationships between SSEF, TPTS, and math academic achievement. Conducting longitudinal studies that track students' academic records over an extended period could provide deeper insights into the temporal dynamics and potential changes in these relationships. Secondly, reliance on self-report measures for assessing both self-efficacy and teacher personality traits introduces the potential for response bias and subjectivity. Future studies could incorporate objective measures, such as classroom observations and external assessments, complemented with qualitative insights through interviews or focus group discussions to enhance the validity of findings. This could provide a deeper exploration of students' and teachers' experiences and perspectives on how self-efficacy and TPTS influence academic achievement.

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