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ORIGINAL ARTICLE

Mediating Role of Mathematics and Science Engagement in the Relationship between Attitude toward STEM Education and Subjective Well-being of Adolescents

R. N. Kavitha, Jacqueline Kareem

School of Education, Christ University, Bengaluru, Karnataka, India

***Corresponding Author:** kavitha.rn@res.christuniversity.in

ABSTRACT

Science, technology, engineering, and mathematics (STEM) education has become a focal point of global discussions in the field of education. It emphasizes an interdisciplinary approach to learning. Subjective well-being of adolescents is characterized as joy to learn, close connectedness in schools, perception of the purpose of education, and the estimation of academic efficiency. This study investigates the mediating role of mathematics and science engagement in the relationship between the attitude toward STEM education and subjective well-being of school students in Kerala. Drawing upon theoretical frameworks from psychology, education, and sociology, this study employs a quantitative approach to data collection and analysis. A sample of 363 secondary and senior secondary students was administered standardized survey tools, measuring attitudes toward STEM education, subjective well-being, and their engagement in mathematics and science classes. Regression and mediation analyses resulted in indicating the positive, mediating effect of mathematics and science engagement in the relationship between the attitude toward STEM education and subjective well-being. Practically, the study suggests that educators should foster positive STEM attitudes through engaging teaching techniques and hands-on activities. Cultivating a positive STEM culture in schools can contribute to students' well-being and equip them for future success in STEM fields.

KEY WORDS: Adolescents; mathematics and science engagement; STEM attitude; STEM education; subjective well-being

INTRODUCTION

In the 21st century, in India, science, technology, engineering, and mathematics (STEM) education marks a significant change from traditional approaches, offering a wide variety of learning experiences that integrate STEM to cultivate diverse skill sets in learners (India STEM Foundation, 2023). This innovative approach promotes active engagement in educational environments, stimulating creativity and problem-solving abilities, rather than simply concentrating on theoretical knowledge. Creating engaging mathematics and science classrooms is crucial for developing interest and proficiency in STEM education (Kennedy and Odell, 2013). Holmlund et al. (2018) advocate through interactive activities, hands-on experiments, and real-world applications, students can develop a deeper understanding of these subjects. Introducing multimedia resources, such as videos and simulations, can further enhance learning experiences by making vague concepts clearer and more reasonable (Leung, 2018; McDonald, 2015). Moreover, encouraging curiosity, critical thinking, and problem-solving skills cultivate a positive attitude toward STEM disciplines. By creating an environment where students feel motivated to explore and inquire, schools can develop the next generation of scientists, engineers, and innovators. The STEM approach is considered to be an integrated method that links concepts and principles from various subjects such as mathematics and science within a technological context (Altakahyneh and Abumusa, 2020).

STEM education in India is going through a significant makeover, which concentrates on generating higher cognitive and social skills in addition to knowledge of STEM (Vishnu et al., 2022). The reason behind this is the growing need to stay ahead in an increasingly technology-driven world and to think out of the box. The government has come up with multiple initiatives, such as Atal Tinkering Labs – under the Atal Innovation Mission – in thousands of schools across the country to inspire creativity and innovation among the next generation (Devrani et al., 2024). These laboratories are equipped with a wide range of tools and equipment to encourage students to take hands-on learning approaches and develop problem-solving skills in their early phases of schooling. Atal stepped up its collaboration with global tech giants, such as Intel, Qualcomm, and Microsoft, to integrate their technologies and promote STEM education in India. Skill India (2016) brochure explains how indigenous investment in digital infrastructure, education, and start-ups has also improved the quality of STEM education in the country. While some challenges remain to be addressed, such as resource disparities among institutions and shortage of trained teachers, there is also a constant need for improvement in the approach to deliver STEM education for more inclusivity and make it more meaningful and useful for all learners (NITI Ayog, 2023).

The STEM education initiatives in Kerala have set the benchmark for quality education and digital literacy. The Kerala Infrastructure and Technology for Education (KITE) program has taken front-running steps to make Information Communication Technology, or ICT, an integral part of school curriculum (Kite(IT@SCHOOL project) – General Education Department, 2014). One of KITE's flagship programs is the "Little KITEs" IT Clubs, which target young students to upgrade their digital skills from an early age (UNICEF study praises Kerala's little kites as a global EdTech model – Times of India, 2024). They focus on building fundamental skills in areas such as coding, robotics, and digital content creation. Through fun activities and engaging projects, "Little KITEs" wants to raise a generation of students who are not only consumers of technology but also innovators and creators (KITE, Annual Report-2021). The state has consistently invested in teacher training and professional development to ensure that educators are well-equipped to deliver high-quality education. In addition, the state has focused on infrastructural upgrades, such as digital classrooms, access to online learning resources, and an environment that support both theoretical and practical aspects of STEM education (Kite Kerala, 2024b). Hence, Kerala is on its way to build a digitally literate population, ready to face the challenges of the modern world. This study aims to explore the link between students' attitude toward STEM education and their well-being, with a particular focus on how engagement in mathematics and science acts as a mediator. The research question raised in this study "To what extent does engagement in mathematics and science mediate the relationship between adolescents' attitude toward STEM education and their subjective well-being."

The twin objectives of the study are first to identify factors within mathematics and science engagement that contribute most significantly to the wellbeing of adolescents and second, to investigate the mediating role of mathematics and science engagement in the relationship between attitude toward STEM education and subjective well-being.

THEORETICAL FRAMEWORK

The present study is based on the social cognitive theory. It emphasizes how personal, environmental, and behavioral aspects interlink with each other (Bandura, 1989). This framework proves that these elements do not operate in isolation but are intertwined. The research focuses on the mediating role of student engagement in the relationship between their attitude and subjective well-being, thereby focusing on the one-way relationship between personal and behavioral factors (Schunk and Mullen, 2012; Sokmen and Kilic, 2019). Personal aspects in this context include cognitive, emotional, and physical traits as described by Dolan (2024). These traits shape how student approach and interact with their environment, influencing their overall engagement in educational activities. Fadiji and Reddy (2023) described personal variables as student involvement, which includes the level of interest, motivation, and commitment students exhibit toward their academic endeavors. Behavioral determinism pertains to individual actions and achievements highlighted by Lin (2020). This research investigates behavioral factors through the eyes of overall well-being, which consists of students' psychological, emotional, and physical health outcomes. With the background support of the social cognitive theory, the study seeks to explain how personal traits, such as involvement, directly influence students' behavior, through which interns promote their well-being (Kulkarni et al., 2023). The complex relationship between engagement and well-being is explored within the framework of emerging educational practices, recognizing that engaged students are more likely to experience higher levels of well-being (Bharti et al., 2023). Gok (2021) identified an increasing number of young learners, particularly in elementary and middle school, showing curiosity and interest in STEM disciplines. They know the significance of these fields in shaping future career opportunities. Traditional memorization techniques and a shortage of stimulating activities can't do anything for students' excitement (Koval-Mazyuta et al., 2023). Hence, access to resources that facilitate interactive STEM education is essential (Vaiopoulou et al., 2024). For this, frequent Quality Improvement Programs and in-service training for teachers are needed. The emotional and psychological background of school students, known as subjective well-being (SWB), has a significant role in their self-esteem, academic performance, enthusiasm for learning, and overall health (Bruk et al., 2024). Kulkarni et al. (2023) in their study explained that SWB is characterized by factors such as feeling connected with the school, enjoying learning, having a sense of purpose in education, and feeling confident about academic abilities. These elements are pivotal in shaping students' experiences and achievements both academically and socially. By examining these interactions, the study aims to provide insights into how increasing student engagement in classrooms can potentially enhance their well-being, offering a valuable perspective for educational practitioners and policymakers to improve student outcomes through targeted interventions and supportive learning environments (Lung, 2018). This understanding is crucial for developing strategies that promote a holistic approach to student development and success in educational settings.

REVIEW OF LITERATURE

Mathematics and Science Engagement

The curricular reforms in India under the National Curriculum Framework (NCF, 2005) established the need for a stronger connection between classroom engagement and day-to-day life experiences of students (Nag Chowdhuri, 2022). It is about truly understanding mathematical concepts, seeing patterns, and using mathematics to solve problems in the real world (Fatta et al., 2009). Classroom engagement encompasses both cognitive engagement such as attention, effort, and persistence in solving mathematical problems and emotional engagement, positive or negative reactions toward the learning environment and activities in the classroom (Sasidharan and Kareem, 2024). When someone really likes mathematics, they do not just learn how to do things, they also understand why they work and how different mathematical ideas connect. This helps them to think critically, analyze information, and reason logically, which are important for school and for life in general. Similarly, science engagement entails a multifaceted approach toward understanding natural phenomena, scientific principles, and technological innovations (Singh and Ningthoujam, 2020). It promotes creativity by encouraging a new vision that challenges and empowers individuals to become conscious citizens, capable of evaluating scientific claims and engaging in evidence- based decision-making (Mani, 2022). Effective mathematics and science engagement are crucial for fostering a scientifically literate and numerate society (Riegle-Crumb et al., 2019).

When individuals are engaged with mathematics and science, they can realize the relevance and significance of these disciplines in addressing social problems, promoting innovations, and making informed decisions, which are essential for success in a rapidly changing global scenario (Jansen et al., 2023; Flores et al., 2021).

Attitude toward STEM Education

Formerly, STEM subjects were seen as obscure and hard to learn for students. But now, people's views on STEM education have changed a lot (Gok, 2021a). It is not just about memorizing facts. It means inculcating in student valuable skills, such as critical thinking, problem-solving, and fact-finding, which are crucial for addressing significant challenges in day-to-day life (Dost, 2024; Kareem et al., 2021). In the present technology-driven world, having a strong STEM background is becoming increasingly important to get a good job and keep the country competitive (Fairhurst et al., 2023; Kalliontzi, 2022). Educators and policymakers are giving more importance to inclusive learning environments, which promote diverse perspectives, ensuring that STEM opportunities are accessible to all (Kalliontzi, 2022; Sasidharan and Kareem, 2023). Moreover, the expanding array of career opportunities, with high-paying jobs, job stability, and opportunities for advancement in STEM fields is attracting a diverse range of students (Sujarwanto et al., 2019). Furthermore, the interdisciplinary nature of STEM education is gaining recognition. By integrating various STEM disciplines, students can explore connections between fields, fostering a holistic understanding and equipping them to tackle a variety of challenging life situations (Sujarwanto et al., 2019).

Subjective Well-being

Diener (1984a) defined subjective well-being as "a person's cognitive and affective evaluations of his or her life" (Diener, 1984a, p.543). The dual nature of subjective well-being, incorporating both cognitive evaluations including life satisfaction and judgment of overall life quality and affective experiences, including emotions and happiness, are well-established in this definition. Similarly, life-values serve as guiding principles that shape our decisions and actions, reflecting what we consider important in life. When our actions align with these values, we often experience a deeper sense of purpose and fulfilment. Subjective well-being, on the other hand, encompasses our overall evaluation of life satisfaction, emotional experiences, and sense of meaning. Recognizing and living by our values can significantly contribute to our overall sense of happiness and fulfilment (Usán Supervía et al., 2023; Iqbal and Dar, 2021). In the classroom environment, students' beliefs in their capabilities and their way of engagement in the classroom play crucial roles in determining their overall well-being (Sasidharan and Kareem, 2023).

METHODOLOGY

This is cause and effect study, which involves studying relationships among variables within a single group and suggesting the possibility of cause and effect (Mashwani, 2022). It examines the mediating role of mathematics and science engagement in the relationship between our attitude toward STEM education and students' subjective well-being. It adopts a survey design using mediation with Structural Equation Modelling, which is a statistical approach to testing hypotheses about the relationships among observed and latent variables (Teo et al., 2013).

Participants

The Indian school system is a complex network that caters to millions of students across various socio-economic backgrounds. It includes state and national boards. The educational boards of each State design the curriculum for state board schools, with their own curriculum and examination patterns (Wikimedia Foundation, 2024). In the present study, the participants are from secondary classes 8-10 and higher secondary classes 11–12. They are from government, government-aided, and unaided schools providing K-12 education in Kerala. In the present study, government and aided school students are considered. The sample consists of students of the age group 14–18 years, selected through convenience sampling, consisting of 363 students, where 244 (67.2%) are secondary and 119 (32.8%) are higher secondary students. In the sample, 193 (53.2%) are female and 170 (46.8%) are male.

Measures

S-STEM survey tool

The tool is developed and standardized by the Friday Institute for Educational Innovation (2012). It is on a five-point Likert scale with 15 questions that measure students' attitude in three domains: Math Attitude: Students' self-confidence in mathematics, enjoyment of mathematics, and perception of mathematics' importance and relevance. Science Attitude: Students' self-confidence in their scientific abilities, enjoyment of science, and perception of science's significance and relevance. Engineering and Technology Attitudes: Students' self-assurance in engineering and technology skills, enjoyment of engineering and technology, and understanding of engineering and technology's importance and relevance.

Mathematics and science engagement scale

A 5-point Likert scale (Wang et al., 2016) has 20 items and a self-report survey instrument designed to measure students' engagement in mathematics and science. Three different dimensions of engagement are measured: behavioral, emotional, and social. Behavioral Engagement: Questions that measure the extent to which students actively participate in mathematics and science classes, such as asking questions, completing assignments, and participating in discussions come under this category. Emotional Engagement: The extent to which students find mathematics and science interesting, enjoyable, and important are considered here. Social Engagement: The method of students' social interactions with peers and adults in mathematics and science classrooms, as well as their willingness to build a bond with peers while learning.

Students' subjective well-being questionnaire (SSWQ)

SSWQ tool (Renshaw et al., 2015) is a self-report behavior rating scale, having 16 items. It measures students' school-specific well-being with reference to the joy of learning, school connectedness, educational purpose, and academic efficacy.

The internal consistency of the instruments was assessed using Cronbach's Alpha to ensure the reliability of the scales. Cronbach's Alpha was used to evaluate the consistency of items within each instrument (Orçan, 2023; Kumar, 2024), with a threshold of $\alpha > 0.60$ indicating acceptable reliability (Table 1).

Procedure

The Institutional Review Board (IRB) at the researcher's university reviewed and approved the study's ethical protocols. The researcher contacted 10 schools in Kollam district, Kerala, and five of them granted permission to collect data. The researcher informed the school authorities about the objectives of the study and requested them to meet the students to brief them about the study's details and their rights, including consent, voluntary participation, withdrawal, and confidentiality. Participants' confidentiality was strictly maintained and participation was entirely voluntary, with no obligation or incentives. Participants could withdraw from the study at any time. The school authorities facilitated the scheduling of data collection. Digital copies of the survey tool were used and it took 10–20 min to complete the questionnaires. The response rate was 97%. The researcher expressed gratitude to the participants and the school authorities for their cooperation and support.

Hypotheses Tested in the Study

- Hypothesis 1: Attitude toward STEM significantly predicts subjective well-being
- Hypothesis 2: Attitude toward STEM significantly predicts mathematics and science engagement
- Hypothesis 3: Mathematics and science engagement significantly predicts subjective well-being
- Hypothesis 4: Mathematics and science engagement significantly mediate between attitude toward STEM and subjective well-being.

Analysis and Results

Data were analyzed using SPSS-20 and AMOS-21 software. Reliability, descriptive statistics, correlation, and regression analysis were computed using SPSS. Mediation analysis was evidenced using structural equation modeling (SEM), which helps to better understand the relationship between variables and also provides direct, indirect, and total effects in a mediation model (Ballen and Salehi, 2021; Sağkal and Sönmez, 2021).

The data were analyzed to determine whether they met the assumptions of normality and multicollinearity. To check the normality of data, skewness and kurtosis values were

Table 1: Coefficients of correlation, mean, SD, Skewness, Kurtosis, and Cronbach's alpha

Predictors	MA	SA	ETA	BE	EE	SE	JOL	SC	EP	AE
SA	0.249**									
ETA	0.151**	0.395**								
BE	0.334**	0.370**	0.245**							
EE	0.470**	0.425**	0.203**	0.633**						
SE	0.265**	0.318**	0.125*	0.525**	0.572**					
JOL	0.294**	0.352**	0.318**	0.432**	0.410**	0.337**				
SC	0.237**	0.271**	0.228**	0.354**	0.329**	0.253**	0.686**			
EP	0.252**	0.340**	0.317**	0.417**	0.425**	0.374**	0.689**	0.703**		
AE	0.280**	0.327**	0.273**	0.439**	0.429**	0.257**	0.677**	0.627**	0.732**	
Mean	3.21	3.82	3.56	3.49	3.5	3.55	3.03	2.98	3.12	3.03
SD	0.738	0.638	0.656	0.543	0.656	0.686	0.718	0.73	0.727	0.731
Skewness	0.247	−0.802	−0.635	0.29	0.177	0.203	−0.333	−0.247	−0.58	−0.3
Kurtosis	−0.186	1.37	0.913	−0.095	0.108	−0.733	−0.585	−0.785	−0.393	−0.81
α	0.682	0.706	0.728	0.601	0.812	0.659	0.683	0.657	0.679	0.724

**Indicating significance at 0.01 level. MA: Mathematics attitude, SA: Science attitude, ETA: Engineering and technology attitude, BE: Behavioral engagement, EE: Emotional engagement, SE: Social engagement, JOL: Joy of learning, SC: School connectedness, EP: Educational purpose, AE: Academic efficacy, SD: Standard deviation, α: Cronbach's alpha computed. Values of skewness and kurtosis in Table 1 are all within the accepted limits of ±1.5 (Tabachnick and Fidell, 2019). To check the assumption of multicollinearity, linear regression tests were conducted, variance inflation factor values of all independent variables were <10, and tolerance was higher than 0.1, reflecting thereby the permissible values. Further, the means and standard deviation were computed for the study variables and detailed in Table 1. The mean values (Table 1) of all the variables were above-average values. Pearson's correlation analysis was used to determine the degree and direction of the relationship between factors of attitude toward STEM, mathematics and science engagement, and subjective well-being. Table 1 confirms that there are significant low-to-moderate correlations between the study variables.

Hypothesis 1: Attitude toward STEM significantly predicts subjective well-being

The outcome of the multiple regression analysis points out that the three predictors of attitude toward STEM explain 29.5% of the variance ($R^2 = 0.295$, $p < 0.001$). Table 2 points out that the proposed model is forecasting the influence of attitude toward STEM on subjective well-being. Considering the R^2 value for the effect size, a value of 0.295 indicates large effect size (Kelley and Preacher, 2012), determining that there is practical significance of the influence of attitude toward STEM education on subjective well-being. It is found that mathematics attitude and science attitude significantly forecast subjective well-being. Hypothesis 1 is supported and hence Attitude toward STEM does significantly influence subjective well-being.

Hypothesis 2: Attitude toward STEM significantly predicts mathematics and science engagement

The outcome of the multiple regression analysis points out that the three predictors of attitude toward STEM explain 21.7% of the variance ($R^2 = 0.217$, $p < 0.001$). Table 3 points out that the proposed model is forecasting the influence of attitude toward STEM on mathematics and science engagement. Considering the R^2 value for the effect size, a value of 0.217 indicates medium effect size (Kelley and Preacher, 2012), determining that there is practical significance in the influence of attitude toward STEM education on mathematics and science engagement. It is found that mathematics attitude, science attitude, and engineering and technology attitude significantly forecast mathematics and science engagement. Hypothesis 2 is supported and hence attitude toward STEM does significantly influence mathematics and science engagement.

Hypothesis 3: Mathematics and science engagement significantly predicts subjective well-being

The outcome of the multiple regression analysis points out that the three predictors of mathematics and science engagement explain 26.5% of the variance ($R^2 = 0.265$, $p < 0.001$). Table 4 points out that the proposed model is forecasting the influence of mathematics and science engagement on subjective well-being. Considering the R^2 value for the effect size, a value of 0.265 indicates large effect size (Kelley and Preacher, 2012), determining that there is practical significance of the influence of mathematics and science engagement on subjective well-being. It is found that behavioral engagement and emotional engagement significantly forecast subjective well-being.

Table 2: Model summary and regression coefficients of attitude toward STEM and its influence on subjective well-being

Predictors	R-square	F	Standardized beta	t	Tolerance	VIF
Mathematics attitude	0.295	50.166**	0.330	7.199**	0.935	1.070
Science attitude			0.340	6.904**	0.807	1.239
Engineering and Technology attitude			0.036	0.750	0.841	1.189

**Indicating significance at 0.01 level

Table 3: Model summary and regression coefficients of attitude toward STEM and its influence on mathematics and science engagement

Predictors	R-square	F	Standardized beta	t	Tolerance	VIF
Mathematics attitude	0.217	33.200**	0.215	4.443**	0.935	1.070
Science attitude			0.237	4.555**	0.807	1.239
Engineering and Technology attitude			0.199	3.910**	0.841	1.189

**Indicating significance at 0.01 level

Table 4: Model summary and regression co-efficient of mathematics and science engagement and its influence on subjective well-being

Predictors	R-square	F	Standardized beta	t	Tolerance	VIF
Behavioral engagement	0.265	43.127**	0.285	4.718**	0.560	1.786
Emotional engagement			0.239	3.815**	0.520	1.924
Social engagement			0.062	1.092	0.629	1.591

**Indicating significance at 0.01 level

Hypothesis 2 is supported and hence mathematics and science engagement do significantly influence subjective well-being.

Hypothesis 4: Mathematics and science engagement significantly mediate between attitude toward STEM and subjective well-being

Structural equation modeling using maximum-likelihood estimates (MLE) is adopted to test the mediation hypotheses. The most common SEM estimation procedure is MLE, a procedure that iteratively improves parameter estimates to minimize specified fit functions.

To analyze the mediation effect, bias correction percentile method is used to calculate the direct, indirect, and total effects (Figure 1). The results in Figure 1 indicate a good model fit: $\chi^2 = 76.335$ (p = 0.000), $\chi^2/df = 2.462$, GFI = 0.962, AGFI = 0.933, NFI = 0.954, CFI = 0.972, IFI = 0.972, RFI = 0.933, TLI = 0.959, PCLOSE = 0.101, and RMSEA = 0.064. Values for the GFI, AGFI, NFI, IFI, RFI, TLI, and CFI above the 0.90 level indicate a good fit. The RMSEA value of <0.08 is indicative of a moderate fit to confirm the hypothesized mediation model (Tabachnick and Fidell, 2019). The analysis results of the direct and indirect effects and the total effect of the mediator on the dependent variables have been shown in Table 5. All the values in the table are standardized β coefficients. It is evident that the direct, indirect, and total effects are significant. The total effect has increased on adding the mediator. Hence, there is a partial mediation effect of mathematics and science engagement on the relationships between attitude toward STEM and subjective well-being. Hypothesis 4 is supported and it is concluded that mathematics and science engagement mediate between the attitude toward STEM and subjective well-being.

DISCUSSION AND IMPLICATIONS

These findings align with prior studies emphasizing the role of engagement in enhancing educational outcomes and well-being (Jansen et al., 2023). Building on the findings of de Faria et al. (2023), Fernandes and Oliveira (2023), Sasidharan and Kareem (2024), the current study reinforces the correlation between fostering a positive attitude toward STEM education, promoting engaging classroom practices and student wellbeing. Educators can implement strategies such as incorporating peer-group activities, interactive learning experiences, and real-life applications of STEM concepts to make learning more engaging and relevant (Sasidharan and Kareem, 2023; Erdoğdu, 2019). Furthermore, investing in educational facilities such as IT-equipped classrooms and enhancing faculty training in classroom management and handling diverse backgrounds (Singh and Ningthoujam, 2020; Devrani et al., 2024) can create a more supportive learning environment. These efforts, in turn, can lead to improved student participation, well-being, and a deeper appreciation for STEM subjects, which is essential for long-term career aspirations in STEM fields (Sasidharan and Kareem, 2023).

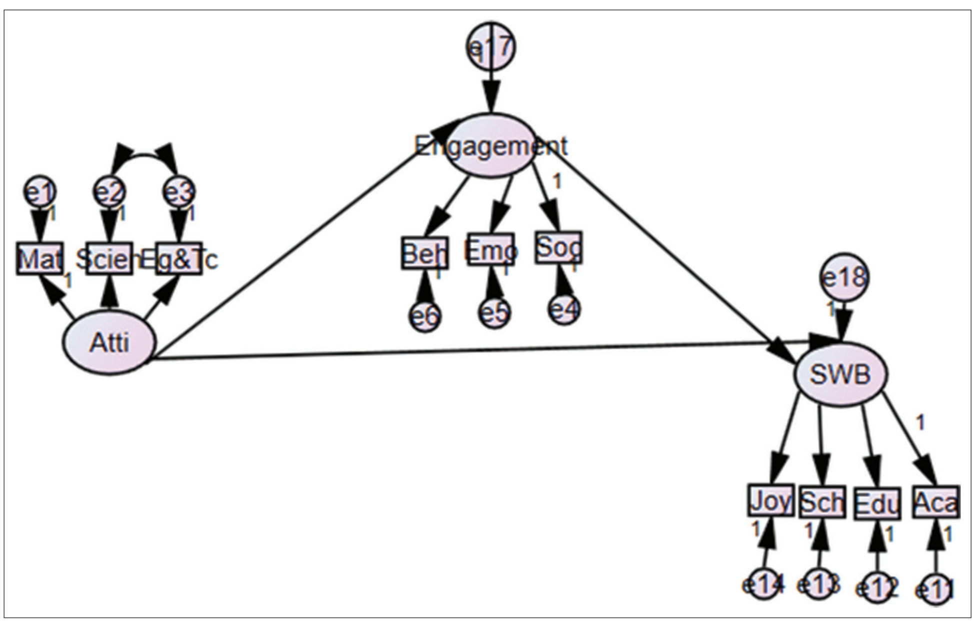

Figure 1: Mediation model of attitude toward STEM, mathematics, and science engagement and subjective well-being

Table 5: Results of mediation analysis

Path	β	Direct effect	Indirect effect	Total effect	Mediation
Mathematics and science engagement <Attitude toward STEM	0.560**	0.612**	0.113**	0.745**	Partial
Subjective well-being <Attitude toward STEM	0.612**				
Subjective well-being <Mathematics and science engagement	0.592**				

Theoretically, the study reinforces existing literature by confirming the link between classroom engagement and students' subjective well-being, as well as the mediating role of engagement in the relationship between attitudes toward STEM and well-being. The findings of the study align with the social cognitive theory, which emphasizes the role of attitude and self-motivation in influencing participation in learning activities (Kareem et al., 2022a). As suggested by Vishnu et al. (2022), this study confirms that believing in oneself leads to more active participation in class, which in turn positively impacts student well-being. Furthermore, the mediation model indicates that mathematics and science engagement plays a crucial role in the relationship between attitude toward STEM and subjective well-being. (Huo, 2022; de Faria et al., 2023). This is again with social cognitive theory, which emphasizes the role of self-motivation and belief in fostering active participation in learning activities (Kareem et al., 2022a). The study also supports previous findings that positive attitudes toward STEM drive engagement in mathematics and science, which subsequently impacts student well-being (Asanjarani et al., 2022; Jansen et al., 2023). By contributing to the theoretical understanding of how attitudes and engagement influence educational outcomes, this research underscores the importance of self-belief and classroom participation in students' overall development, particularly for teenagers (Blotnicky et al., 2018; Boulton et al., 2019; Hill et al., 2021).

The study builds on social cognitive theory, which explains how personal, environmental, and behavioral factors interact to influence learning outcomes (Bandura, 1989). Studies by Sasidharan and Kareem (2023) reinforce that student involvement directly impacts wellbeing, aligning with our findings. Theoretical foundation is strengthened by the expectancy-value theory (Gladstone et al., 2022), which suggests that students engage in subjects they find valuable and relevant. This provides a more relevant explanation for why mathematics and science engagement mediate the relationship between STEM attitude and well-being.

CONCLUSION

This research has effectively addressed the question of how personal traits influence student behavior, specifically focusing on the relationship between student engagement and overall well-being within the framework of social cognitive theory. This study confirms that engaging students in STEM boosts their overall well-being. The study highlights the critical role of engaging and interactive educational strategies, such as hands-on activities and real-world applications, in fostering deeper interest and sustained engagement among students. For students, teachers, and administrators, the takeaways are profound: students benefit from a more engaging and supportive learning environment that can support their academic and emotional growth; teachers gain insights into effective pedagogical practices that can improve student-teacher rapport and classroom dynamics; administrators are reminded of the importance of investing in quality classroom facilities and resources that facilitate interactive learning and policymakers are provided with evidence to advocate for policies that promote engaging, inclusive, and well-supported STEM education. Collectively, these insights establish the need for a holistic approach to education that prioritizes both academic success and well-being of students, ensuring the development of a motivated, proficient, and emotionally healthy future workforce in STEM fields.

The broader implications of these findings suggest that educators should implement interactive learning strategies, such as peer-group discussions, project-based learning, and real-world applications to enhance engagement. In addition, differentiated instructional approaches tailored to students' interests and capabilities can help sustain engagement overtime. By incorporating adaptive learning technologies and personalized feedback mechanisms, educators can create more inclusive STEM learning environments that cater to diverse student needs. Policymakers should develop policies promoting STEM curricula that emphasize experimental learning rather than rote memorization. Schools should invest in well-equipped STEM laboratories that encourage hands-on learning experiences and create supportive learning environments where students feel motivated to participate.

Limitations and Suggestions for Further Study

Limitations of the study are as follows: First, students report their own experiences, which might be influenced by a desire to give socially desirable answers and second, the study does not consider factors such as gender, socio-economic background, and other demographics that might affect students' learning. Third, the results only apply in a particular rural area with a specific socio-economic and age range. This limits how well the findings can be applied to other situations. In addition, other factors, such as motivation, interest, and learning strategies also influence students' well-being. However, these are not examined in this study.

While this study provides valuable insights, its generalizability is somewhat limited due to the specific demographic and geographical focus. Building on the foundations of the study, future research can delve deeper into the relationships explored. Specific factors that can affect students' engagement and attitude can be examined in detail. In addition, incorporating additional variables such as socioeconomic status, cultural influences, and parental involvement could provide a more comprehensive understanding of the factors influencing student engagement and well-being. Moreover, experimental studies could be conducted to test interventions aimed at enhancing students' engagement and subsequently assessing the impact on their well-being. By employing rigorous experimental designs, researchers can establish causal relationships and provide evidence-based recommendations for educational practices. Quantitative and mixed-method studies could complement quantitative findings by exploring the perspectives of teachers, parents, and students themselves. Understanding their perceptions and experiences within the learning environment could inform the development of more effective interventions and instructional strategies. In continuation of this study's groundwork and addressing these avenues for further research, researchers can contribute to advancing knowledge in the field of STEM education and promoting students' well-being.

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