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Navigating Mathematical Challenges: Enhancing Mathematical Buoyancy among Rural Students for Tertiary-Level Preparedness

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Abstract: This study delves into the crucial area of sustaining STEM (Science, Technology, Engineering, and Mathematics) education, recognising the necessity of a solid foundation in scientific disciplines for students to be eligible for STEM programs. Focusing on mathematical buoyancy as a key factor, the research explores how mathematics proficiency contributes to successful STEM learning. The study posits that mathematically buoyant students, with cognitive fortitude gained through sustained math education, can navigate challenging STEM content more effectively. Highlighting the challenges students face, particularly in complex learning environments, this study underscores the importance of cultivating mathematical buoyancy, especially among students in rural areas. Through a correlational study involving 456 students from two rural areas in Malaysia, the research investigated the influence of self-regulated learning and achievement goal orientation on mathematical buoyancy. The findings revealed significant contributions of self-regulated learning and achievement goal orientation to mathematical buoyancy. The study emphasises the need to reinforce these factors to enhance adolescents' ability to cope with mathematical setbacks and adapt to environmental changes. Securing this ability eases mathematics learning in universities. Ultimately, this study provides valuable insights for rural students, guiding them towards building mathematical buoyancy for sustainable education and economic development. Aligning with SDG 4 (quality education) in the 2030 Agenda, the study calls for further actions to address national priorities and needs, promote a robust foundation for STEM education and foster long-term economic growth.

Keywords: Achievement Goal Orientation, Buoyancy, Mathematics, Self-Regulated Learning, STEM

1. Introduction

Mathematics plays a vital role in sustainable development by cultivating essential skills, fostering perseverance, and enabling individuals to address real-world challenges (Karjanto & Acelajado, 2022). Monitoring students' buoyancy gives advantages to keeping students' attitudes in resilience throughout their academic journey (Martin & Marsh, 2008). The global recognition of its contributions to sustainable development in Science, Technology, Engineering, and Mathematics (STEM) has been acknowledged since preservice teachers and mathematics educators were encouraged to develop efficacious strategies for integrating education to pursue this objective (Su et al., 2023). A mathematical understanding is an investment in the future success of the student and equips them with the skills necessary to contribute significantly to STEM initiatives in a variety of contexts and disciplines. Individuals who possess a strong command of mathematics are more inclined to embrace a growth-oriented mindset and demonstrate resilience in the face of obstacles, thereby positioning themselves to understand sustainable development, specifically in the STEM fields (Boaler et al., 2021; Karjanto & Acelajado, 2022; Widiati & Juandi, 2019). Thus, buoyancy in mathematics is essentially cultivated for the preparedness to pursue the subject in universities specifically and to achieve higher academic achievement in STEM subjects generally.

Nevertheless, a research gap exists regarding the specific aspects through which mathematics education cultivates these attributes (Para & Johnston-Wilder, 2023). While it is acknowledged that proficiency in mathematics is associated with adopting a growth mindset of improvement and persevering through challenges to avoid anxiety(Omar et al., 2022), further empirical research is needed to explore the causal relationships between mathematical proficiency, mindset development, and academic buoyancy, especially among less-opportunity students in education among rural students. Understanding how mathematics education influences the growth of these traits can assist teachers in creating effective teaching methods that foster mathematical confidence and enhance students' abilities to make meaningful contributions to STEM projects. Hence, this study aims to investigate the extent to which factors (achievement goal orientation and self-regulated learning) influence a resilience-related construct in mathematics, called mathematics buoyancy. This study addresses the following research questions: (1) What are rural students' levels of mathematics buoyancy, self-regulation, and achievement goal orientation? (2) Is there any relationship between mathematical buoyancy and the factors of self-regulation, and achievement goal orientation? (3) To what extent do the factors contribute to mathematical buoyancy?.

2. Literature Review

2.1 Mathematics for Sustainable Development in STEM

Mathematics, known for its inherent challenges and complexity (Antonietti & Cantoia, 2000), frequently necessitates dedicating extra time to learn and apply. The underlying complication of this subject (mathematics) often requires learners to invest additional time to engage in deep critical thinking. Profound critical thinking involves reasoning and mathematical representation, which are part of the mathematical process. By actively engaging in the rigorous task of mathematical understanding, learners can develop essential skills, such as problem-solving skills, logical reasoning abilities, and analytical thinking (Hui et al., 2016; Monrat et al., 2022). It is evident among female students who exhibited proficiency in manipulating mathematical concepts and persevered in acquiring STEM knowledge (Joseph et al., 2020), thereby significantly contributing to the sustained advancement of STEM education. As a result, mathematics serves as a fundamental pillar for fostering sustainable development within STEM disciplines. Consequently, the process of learning mathematics encompasses cognitive aspects that may demand perseverance from the learner to navigate through these difficulties. The ability to endure and persist through this process demonstrates an individual's commitment to overcoming obstacles in the realm of mathematics reflects a broader dedication to sustainable education. Thus, despite its challenges, mathematics holds significant potential for fostering sustainable development in STEM.

2.2 Fostering a More Sustainable and Equitable Future with Mathematics

As mathematics provides powerful tools for analysing data, making informed decisions, and modelling complex systems, its importance as a discipline is growing (Shikhman & Müller, 2021). With the rising demand for data analysis tools, mathematics' powerful instruments are required for society to meet its current challenges. New conditions, numerous natural disasters, climate change, and many other obstacles make it extremely difficult to manage the world in the present day. Students can establish themselves as contributors to sustainable development efforts by employing mathematical concepts and techniques to real-world issues. They can, for example, investigate mathematical modelling to resolve environmental issues, maximise resource allocation, analyse economic systems, and evaluate social dynamics.

In addition, mathematics serves as a foundation for other STEM disciplines (Science, Technology, Engineering, and Mathematics). Learning mathematics requires individuals to engage in the mathematical process, namely reasoning, and problem-solving, which has propelled students into STEM fields (Mohamed Elsayed, 2022). Consequently, proficiency in mathematics enables individuals to embrace STEM knowledge to tackle challenges in disciplines such as engineering, computer science, and data analysis, which are essential for driving innovation and sustainable technological advancements.

On top of that, mathematics serves as a universally understandable language. It encourages individuals from diverse origins to collaborate and share their experiences, insights, and solutions with some mathematical calculations for making decisions to promote global sustainable development (Goos & Halai, 2022). To modernise agricultural technology and contribute to sustainable development, farmers must, for example, communicate with one another for a calculated budget, timing, and computational solutions for fertilisation during the planning or construction of a digitalised farm. In today's STEM-advanced society, crop yield is estimated using a mathematical formula (Mishachandar & Vairamuthu, 2021).

To fully embrace the potential of mathematics for sustainable development, it is essential to promote inclusive and equitable school learning access. By emphasising learning in school education, all students, including those from less developed regions, are afforded the chance to engage in classroom discourse. By assuring that all individuals, regardless of their background or circumstances, can develop mathematical skills, everyone can foster a more sustainable and equitable future.

2.3 Importance of Mathematics Buoyancy

As a crucial framework for addressing the challenges of economic growth, social equity, and environmental preservation, sustainable development has garnered considerable global interest. As a foundational discipline, mathematics plays a crucial role in promoting sustainable development through the application of its powerful problem-solving tools.

The sustainable growth of mathematical knowledge necessitates a resilient mentality, specifically mathematical buoyancy, for overcoming complex conceptual obstacles (Neumann et al., 2021). Many mathematical tasks, such as mathematical models that predict complex environmental processes, demonstrate the innovative application of difficult mathematical concepts. Mathematics buoyancy is related to managing challenging cognition within mathematical knowledge, coping with mathematical knowledge so that individuals can continue developing cognition, and understanding how mathematics facilitates optimisation and resource allocation, which are crucial for sustainable resource management. Implementing mathematical methods contributes to sustainable development by facilitating cost-effective solutions and improved resource management practices. Consequently, encouraging mathematical buoyancy among school children should be promoted (Neumann et al., 2021). In addition to emphasising STEM activities, teachers must encourage students to face the complexity of mathematics with courage.

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2.4 Relationship between Mathematics Buoyancy, Self-regulated Learning, and Achievement Goal Orientation

Mathematics buoyancy, self-regulated learning (SRL), and achievement goal orientation (AGO) are interrelated constructs that have garnered significant attention in the field of mathematics education. Hence, it is essential to explore the relationship between these three constructs, aiming to understand how they contribute to students' mathematical achievement and engagement (Rameli, 2017; Rameli & Kosnin, 2018).

Mathematics buoyancy refers to students' resilience, confidence, and positive attitudes toward mathematics (Rameli & Kosnin, 2018). It encompasses students' beliefs in their abilities to succeed in mathematics, even when faced with daily and minor challenges or setbacks. Research has shown that mathematical buoyancy is a strong predictor of mathematical achievement (Bandura, 1997). Students with high mathematics buoyancy are more likely to persist in their mathematical endeavours, seek assistance when needed, and adopt a growth mindset, which is mediated by their self-efficacy and leads to higher academic performance (Dong et al., 2023).

Self-regulated learning (SRL) is a cyclical process in which learners actively monitor, control, and regulate their cognitive processes, motivations, and behaviours to achieve academic goals (Li, 2022; Zimmerman, 2000). SRL involves various strategies such as goal setting, planning, monitoring, self-reflection, and self-evaluation. Studies have consistently shown that students who engage in self-regulated learning exhibit higher levels of academic achievement (Pintrich, 2004). By actively managing their learning process, students can adapt their strategies, seek help, and overcome challenges, leading to improved mathematical performance.

Achievement goal orientation refers to students' orientation towards achieving mastery and understanding of mathematical concepts rather than solely focusing on performance outcomes (Renninger & Hidi, 2019). Students with a strong goal orientation tend to adopt a deep learning approach, engaging in activities that promote understanding, conceptual thinking, problem-solving, demonstrating higher levels of intrinsic motivation, engagement, and academic achievement (Pintrich, 2000). By valuing the process of learning and seeking to understand mathematical concepts deeply, students are more likely to persist in the face of challenges and develop a positive attitude towards mathematics.

The relationship between mathematics buoyancy, self-regulated learning, and achievement goal orientation is highly intertwined (Rameli, 2017). Students with high mathematics buoyancy are more likely to engage in self-regulated learning strategies and adopt an achievement goal orientation. Facilitating the engagement in self-regulated learning processes will have the potential to enhance students’ belief in their ability to succeed (mathematics buoyancy). Similarly, an achievement goal orientation adoption, which focuses on achieving understanding and mastery, will increase students’ capability to deal with academic challenges.

While research has individually examined the impact of mathematics buoyancy, self-regulated learning, and achievement goal orientation on mathematics achievement, further research is needed to explore the complex interplay among these constructs among rural area students who have unique learning environments, namely learning takes place in less facilitated areas. Longitudinal studies investigating the reciprocal relationships between mathematics buoyancy, self-regulated learning, and achievement goal orientation can shed light on the dynamic nature of these constructs and their joint influence on students' mathematical outcomes. Additionally, the research could explore instructional approaches and interventions that promote the development of mathematics buoyancy, self-regulated learning, and achievement goal orientation, ultimately leading to enhanced mathematical achievement and student engagement.

3. Research Methodology

This study employed a correlational research design to gather quantitative data, aiming to develop a model that explores the relationships among the variables. The data collection process involved administering a questionnaire, as outlined in the instrumentation section, to gather data specific to each variable.

Participants were recruited from four secondary schools covering two areas in Peninsular Malaysia. This study aims to involve secondary school students in rural areas, which are named clusters for the application of cluster sampling. In the cluster sampling, schools in each area were named "a cluster" so that two schools could be randomly selected by taking two areas since these target populations have enough students (namely 384 participants) to achieve a figure ensuring the satisfaction of the assumption of normal distribution. The sample size is sufficient based on calculation with a degree of variability that is not known, assuming the maximum variability, namely 50%, and a 95% confidence level with ±5% precision for the collected data as described in sample determination (Krejcie & Morgan, 1970). Thus, randomly, the two areas were determined. They were from the southern and eastern rural areas. Then, a total of 456 participants were randomly selected from two schools in the two areas. They were between 15 and 16 years old. The distribution of participants across genders showed almost a balance, with 54% being female and 46% being male.

Data were collected using three survey instruments to assess three main variables: mathematics buoyancy, self-regulated learning, and achievement goal orientation. To measure mathematical buoyancy, a questionnaire called The Academic Buoyancy Scale (Rameli, 2017) was adopted. This scale has 28 items designed to gauge a student's resilience despite typical obstacles encountered while studying mathematics. The questionnaire has eight different subscales to assess: self-perception, learning practice, teachers' character, teachers' teaching practice, parents' internal support, parents' external support, peer support, knowledge and skills. Cronbach's Alpha for the scale was 0.91, indicating high levels of reliability within the scale itself.

To assess self-regulation learning, the Self-Regulated Learning Questionnaire (Wu, 2005) was used. This instrument consists of 35 items to gauge the three subscales of self-regulated learning (forethought, performance, and reflection). All subscales were shown to have reliability coefficients of more than 0.7 (Chang et al., 2013).

Lastly, to assess achievement goal orientation, part (a subscale) of an existing questionnaire called the Achievement Goals Questionnaire (AGQ) (Elliot & McGregor, 2001) was adopted. The questionnaire measures four types of achievement goal orientation: mastery approach, mastery avoiadance, performance approach and performance avoidance. The reliability of this instrument was reported above 0.7, indicating convincing reliability above 0.7 (Tuan et al., 2005).

Respondents provided their feedback based on a four-point scale (1=strongly disagree; 2=disagree; 3=agree; 4=strongly agree) for all surveys. Table 1 shows some of the items for all three variables.

Table 1. Items in the Achievement Goal Questionnaire

	Sample items
Self-regulation	• I believe I can understand the most difficult part of mathematics. • I think I can apply mathematics lessons to other subjects.
Achievement goal orientation	• It is important for me to know the contents of the mathematics subject thoroughly. • I want to learn as much as possible in mathematics class.
Mathematics buoyancy	• I am confident in my mathematics abilities while having worrisome thoughts that math is pointless. • I want to learn mathematics even if I can't get help from others when I have problems solving mathematics questions.

4. Results and Discussion

The following findings were presented according to each research question, reflecting the target population's mathematics buoyancy in comparison to self-regulation and achievement goal orientation. Subsequently, the data were further analysed to gain a clearer understanding of how self-regulation and achievement goal orientation affect mathematics buoyancy.

4.1 Finding 1: Descriptive analysis of buoyancy as compared to self-regulation and achievement goal orientation

Finding 1 was presented to answer research question one: "What are rural students' levels of mathematics buoyancy, self-regulation, and achievement goal orientation?". Table 2 presents the means of the variables investigated in the study. The results indicate that students rated their levels of mathematics buoyancy at a moderate level with a mean of 2.815 (standard deviation = 0.367), when compared to the full rating scale used in this study, namely 'strongly agree' with a score of '4'. The descriptive indicator for mathematics buoyancy suggests that students demonstrated an average level of agreement with mathematics buoyancy. The satisfaction level of mathematics buoyancy indicated that they were in the improvement stage of learning mathematics as supported by the identified levels of self-regulation and achievement goal orientation. The moderate level of self-regulation, with a mean 2.878 (standard deviation = 0.368), suggests that students demonstrated self-regulation while working with mathematics. They perceived themselves similarly for their abilities in mathematical buoyancy and attitudes towards self-regulation. On the other hand, they exhibited a higher rating for achievement goal orientation with a mean of 3.041 (standard deviation = 0.565). Consequently, the students were confident in their existing ability to demonstrate a mastery approach to learning mathematics showing awareness of their learning contents and consistent aim for improvement.

Table 2. Descriptive statistics: self-regulation, goal orientation and mathematics buoyancy

	Mean	Std. Deviation
Self-regulation	2.878	0.368
Achievement goal orientation	3.041	0.565
Mathematics buoyancy	2.815	0.367
Valid N (listwise)		

The findings from this study indicated the levels of mathematics buoyancy, self-regulation, and achievement goal orientation among rural students. The mean score for mathematics buoyancy was 2.815, suggesting a moderate level of mathematics buoyancy among the students. This indicated that, on average, the students demonstrated a positive attitude and confidence in their ability to succeed in mathematics, although there was room for improvement. The students' satisfaction level with mathematics buoyancy indicated that they were in the process of improving their understanding and performance in mathematics.

The study also revealed that the students exhibited a moderate level of self-regulation, with a mean score of 2.878. This suggests that the students demonstrated the ability to regulate their learning processes and engage in self-directed strategies while working on mathematics tasks. The students' awareness of their abilities in mathematics buoyancy and their attitudes towards self-regulation indicated that they recognised the importance of actively managing their learning process to enhance their mathematical skills.

Furthermore, the students reported a higher rating for achievement goal orientation, with a mean score of 3.041. This indicates that the students were confident in their ability to demonstrate mastery in learning mathematics. They clearly understood the learning content and consistently aimed for improvement. The higher rating for achievement goal orientation suggests that the students were motivated by the intrinsic value of understanding mathematical concepts rather than focusing solely on performance outcomes.

The findings suggested that the rural students demonstrated a moderate level of mathematics buoyancy, self-regulation, and a strong achievement goal orientation. This indicated a positive foundation for their engagement and achievement in mathematics. However, it is important to note that the mean scores indicate room for improvement in mathematics buoyancy and self-regulation with a mastery level of mathematics. Only after attaining a mastery level in mathematics can students have full confidence in their mathematical knowledge to advance to more difficult mathematics. Consequently, addressing academic disparities and achieving academic equity in mathematics (as outlined in SDG 4) may convince students to cultivate mathematical buoyancy. Regarding SDG 4, teachers' responsibilities include continuing to monitor pupil performance throughout the learning process. Therefore, teachers must exert more effort to evaluate mathematical skills (Valli et al., 2007), including involving parents' support (Hoon et al., 2021). Moreover, addressing the buoyancy level in mathematics is consistent with SDG 4, which aims to ensure quality education by equipping students with the essential skills for their future success in university and, consequently, sustainable economic growth. These findings highlight the potential for interventions and instructional strategies that target enhancing mathematics buoyancy, self-regulation, and achievement goal orientation among students, ultimately leading to improved mathematics learning outcomes.

Students with a strong achievement-goal orientation are motivated to enhance their competence by engaging in diligent and challenging study (Murphy & Alexander, 2000). This understanding strongly suggests that achievement goal orientation has a major impact on self-regulated learning (Xi Lin, 2019). Nevertheless, even though a student shows a strong intention of learning for specific knowledge as well as a drive to face competitiveness, students, particularly those at tertiary levels, are urged to look for various self-regulated learning strategies during the learning process. The learning process occurs across diverse settings (Lodge et al., 2018) and entails unique forms of interaction, such as communication, reasoning abilities, and various cognitive processes. Due to the multifaceted nature of mathematics, the process of self-regulated learning can be intricate and necessitate a longer period of development. Therefore, it is crucial to prioritise the cultivation of self-regulated learning in order to achieve success in the acquisition of mathematical knowledge (Harding et al., 2019).

4.2 Finding 2: Relationship among Mathematics Buoyancy, Self-regulation, and Achievement Goal Orientation

Finding 2 was presented to answer research question 2, namely, "Is there any relationship between mathematics buoyancy and factors of self-regulation and achievement goal orientation?". The correlation analysis findings as presented in Table 3, reveal intriguing connections among the variables. Mathematics buoyancy exhibits the strongest correlation ($r = 0.697$, $p < 0.001$) with self-regulation, indicating a significant positive relationship between these two factors. This suggests that students with a positive attitude towards mathematics and confidence in their abilities are more likely to possess strong self-regulation skills. Furthermore, mathematics buoyancy also showed a moderate correlation ($r = 0.411$, $p < 0.001$) with achievement goal orientation, implying that students with a resilient mindset towards mathematics were more inclined to adopt a mastery approach to achieving their goals. This results suggest that both self-regulation and achievement goal orientation play equally important roles in contributing to mathematics buoyancy.

Table 3. Relationship between mathematics buoyancy with self-regulation and achievement goal orientation

		Self-regulation	Achievement Goal Orientation
Mathematics buoyancy	Pearson Correlation	0.697^{**}	0.411^{**}
	Sig. (2-tailed)	<0.001	<0.001

Several studies in the literature support the idea that both self-regulation and a mastery approach to achieving goals are equally important in contributors to mathematics buoyancy. Research consistently shows that self-regulation plays a crucial role in academic achievement and fosters positive attitudes towards learning. Students who can effectively regulate their thoughts, emotions, and behaviours tend to exhibit higher levels of academic self-efficacy and engagement (Zhen et al., 2017), leading to increased buoyancy in mathematics (Rameli, 2017; Rameli & Kosnin, 2018). Similarly, adopting an achievement goal orientation, which emphasises competence development and mastery of tasks, has been linked to greater motivation, engagement, and persistence in academic pursuits. Students who set achievement-oriented goals are more likely to view challenges as opportunities for growth, leading to a positive perception of their mathematical abilities and enhancing their mathematical buoyancy (Rameli & Kosnin, 2018). Therefore, integrating both self-regulation and a mastery approach to secure achievement goal orientation is essential for fostering mathematics buoyancy among students.

4.3 Finding 3: Factors Contributing to Mathematics Buoyancy.

Finding 3 was presented to answer research question 3, namely, "To what extent do the factors contribute to mathematics buoyancy?". The regression analysis as depicted in Table 4, reveals the extent to which the two factors (self-regulation and achievement goal orientation) contribute to mathematics buoyancy. To assess this, the R-square value was examined, as illustrated in Table 4. The results indicate that a total of 50.7% of the variation in mathematics buoyancy could be predicted by self-efficacy and achievement goal orientation.

Table 4. Model summary of the regression analysis

Model	R	R Square	Adjusted R Square	Std. The error in the Estimate
2	0.714^b	0.509	0.507	0.25692

Predictors: (Constant), self-regulation, achievement goal orientation

The result of the ANOVA analysis (Table 5) shows the model was significant with F = 235.166 and $p < 0.05$. The model's prediction of the dependent variable, mathematics buoyancy is significant for the predictors (independent variables) of self-regulation and achievement goal orientation. Therefore, the result suggests that the prediction of mathematics buoyancy was significant based on the factors of self-regulation and achievement goal orientation.

Table 5. ANOVA for the indication of a significant model

Model		Sum of Squares	df	Mean Square	F	Sig.
	Regression	31.045	2	15.522	235.166	0.000^b
	Residual	29.901	453	0.066		
	Total	60.946	455			

b. Predictors: (Constant), self-regulation, achievement goal orientation

c. Dependent Variable: mathematics buoyancy

Specifically, the significant model is presented below. The model (Table 6) is constructed with the independent variables of self-regulation and achievement goal orientation.

Table 6. Coefficients for the construction of the model

Model		Unstandardised Coefficients		Standardised Coefficients		
		B	Std. Error	Beta	t	Sig.
2	(Constant)	0.764	0.096		7.979	0.000
	Self-regulation	0.572	0.040	0.575	14.256	0.000
	Achievement goal orientation	0.133	0.026	0.205	5.090	0.000

a. Dependent Variable: mathematics buoyancy

The following is the model:
Mathematics buoyancy = 0.575 (self-regulation) +0.205 (achievement goal orientation)

The coefficients in the model provide information about the strength and direction of the relationships between these variables. According to the model, self-regulation is the more influential factor, as it has a higher coefficient of 0.575 compared to achievement goal orientation, which has a coefficient of 0.205. This suggested that self-regulation played a more substantial role in predicting mathematical buoyancy. A one-unit increase in self-regulation was associated with a 0.575-unit increase in mathematics buoyancy, while a one-unit increase in achievement goal orientation was associated with a 0.205-unit increase in mathematics buoyancy. The model provided valuable insights into the relative contributions of self-regulation and achievement goal orientation in explaining and understanding mathematical buoyancy.

The findings of the model, which examined the coefficients and their implications for predicting mathematical buoyancy, were consistent with previous research in the field. Numerous studies have highlighted the significance of self-regulation for academic achievement and student motivation (Sahranavard et al., 2018). Self-regulation encompasses various cognitive, metacognitive, and behavioural processes, as well as motivation and emotion (Panadero, 2017), that enable individuals to control and direct their learning. It involves setting goals, monitoring progress, managing time effectively, and employing strategies to overcome challenges. The higher coefficient (0.575) for self-regulation indicates that it has a stronger influence on mathematical buoyancy. This aligns with research that suggests individuals with strong self-regulation skills are more likely to demonstrate higher buoyancy in mathematics (Weißenfels et al., 2022).

Furthermore, the coefficient for achievement goal orientation (0.205) indicated that it also contributed positively to mathematics buoyancy, albeit to a lesser extent. Previous studies have emphasised the importance of adopting a goal orientation, which focuses on learning and skill development (Rameli, 2017; Rameli & Kosnin, 2018), as it positively impacts students' motivation and attitudes towards mathematics. Overall, this model provided valuable insights into the relative contributions of self-regulation and an achievement goal orientation in explaining and understanding mathematics buoyancy, highlighting self-regulation as the more influential factor.

5. Conclusion

In conclusion, the findings of this study have important implications for sustainable development (SDG4), particularly in the context of SDG 4.1.1 and SDG 4.1.2. The positive correlations observed between mathematics buoyancy, self-regulation, and achievement goal orientation highlight the significance of these factors in promoting quality education and lifelong learning opportunities, particularly at the university level. By fostering self-regulation skills and cultivating a goal-oriented mindset, educators can empower students to become active learners and critical thinkers, which aligns with SDG 4.1.1's goal of ensuring inclusive and equitable quality education for all and the achievement of a minimum proficiency level in mathematics. Furthermore, the model analysis revealed that self-regulation is more influential in predicting mathematical buoyancy. This emphasised the importance of integrating self-regulation strategies to enhance students' ability to embrace academic challenges into educational practices, promising a high completion rate for schooling and further in the university's studies. This can contribute to the achievement of SDG 4.1.2, which aims to ensure that all learners acquire the knowledge and skills needed to promote sustainable development without being left out. By nurturing mathematics buoyancy through self-regulation and achievement goal orientation, students' adaptive capacity and academic success can be supported. It is anticipated that this will enhance their positive attitudes, strengthen their resilience towards mathematics, and ultimately contribute to the broader goals of sustainable development. It is also worth noting that this study provides valuable insights into the levels of mathematics buoyancy, self-regulation, and achievement goal orientation specifically among rural students. However, further research is needed to explore these constructs in different contexts and populations to gain a more comprehensive understanding of their relationships and potential implications for mathematics education. Future research could also look into how well interventions or teaching methods work at improving students' mathematical confidence, ability to self-regulate, and focus on achievement goals. This could lead to better math achievement and interest among students with balanced mathematical buoyancy.

5. Co-author contribution

The first author conceptualised the paper, collected data and compiled the sections* while the rest of the authors analysed the data and wrote the different sections.

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