A Mediation Analysis on Mathematics Classroom Environment, Motivation, Engagement, And Performance among College Students in a Private Higher Education

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ABSTRACT

Mathematics in the Modern World aims to develop college students' logical reasoning and problem-solving skills; however, many students struggle with its abstract nature. This study investigated whether the mathematics classroom environment influences college students' mathematics performance through the sequential mediation of motivation and engagement, thereby addressing a knowledge gap in the context of Mathematics in the Modern World (MMW) at a private higher education institution. A descriptive, cross-sectional, correlational design was employed, and data were collected from 342 first-year students using stratified random sampling. Descriptive findings revealed that students perceived their classroom environment, motivation, and engagement as high, with extrinsic motivation and behavioral engagement standing out; nevertheless, mathematical performance was only fairly satisfactory. Mediation analyses found that the classroom environment had no significant direct effect on performance and no significant indirect effect through motivation alone. Instead, the serial indirect pathway in which classroom environment influenced motivation, motivation influenced engagement, and engagement affected performance was significant, while the indirect effect of engagement alone was also significant. These findings demonstrate that simply establishing a good learning environment is insufficient; instructors may strategically provide opportunities for students to transform motivational drive into observable engagement. The validated serial mediation model provides a useful framework for instructional interventions in General Education Mathematics courses.

Keywords: Mathematics Education, Mediation Analysis, Student Engagement, Mathematics Performance, Central Philippines

INTRODUCTION

In the 21st century, mathematics is valued not only as an abstract science but also as a practical tool for everyday reasoning. The Commission on Higher Education (CHED) introduced Mathematics in the Modern World (MMW) through CMO No. 20, series of 2013, to foster critical thinking and problem-solving using real-world applications (Bangalan & Hipona, 2020; Commission on Higher Education, 2013; Edu et al., 2025). However, conventional instructional approaches often struggle to capture student interest or change the widespread belief that mathematics is inherently challenging and disconnected from reality (Antao et al., 2024; Gumartifa et al., 2023; Mutia, 2025; Panerio & Delideli, 2025). Studies confirm that many students display low interest and poor computational skills in MMW, reflecting persistent difficulties in mastering the subject (Carbonel et al., 2022; Endocal & Baraquia, 2025). The urgency of this issue is underscored by the 2022 PISA results, which showed that 16% of Filipino pupils achieved at least Level 2 competency in mathematics, a figure much lower than the OECD average (OECD, 2023).

The classroom environment, encompassing physical, social, and psychological factors, is a fundamental predictor of academic success in higher education, profoundly influencing student learning (Wilkins et al., 2021). Key dimensions include teacher support, which helps students overcome challenges, and student autonomy, reflecting learners' control over their learning (Han, 2021; Ulmanen et al., 2023). Moreover, student satisfaction is associated with positive perceptions of teaching and resources, whereas learning difficulties pose obstacles to understanding mathematics (Elastika et al., 2021; Feng et al., 2025). In addition, the classroom environment balances cooperation to build teamwork and competition for better motivation, new teaching methods to spark creativity and engagement, and discipline to keep a focused learning space (Ispas & Ispas, 2023; Linao, 2025; Wongvorachan, 2023). Effective classroom management and teacher autonomy support have been shown to significantly predict mathematics achievement and fulfill students' psychological needs for motivation (Asare et al., 2024a; Soe et al., 2025a).

Motivation, which includes internal and external factors that influence students' efforts in mathematics, is a critical driver of the learning process (Jaafar & Maat, 2020; Rone et al., 2023). Intrinsic motivation comes from genuine interest and enjoyment, leading to deep engagement, while extrinsic motivation arises from external rewards or pressures (Fiorella et al., 2021; Hossein-Mohand & Hossein-Mohand, 2023; Shuaili, 2025). Perception in mathematics refers to a student's feelings, interests, and attitudes toward the subject (Salifu & Bakari, 2022). Extrinsic motivation can effectively drive academic effort, especially when students respond to structured rewards (Dangi et al., 2025; Hidayatullah et al., 2024). Many Filipino students are willing to improve, yet only about 19 percent reach basic proficiency, highlighting the importance of motivation (Carandang et al., 2024). However, motivation alone is insufficient; it must translate into active engagement to affect learning outcomes.

Student engagement includes behavioral, emotional, and cognitive dimensions (Sen, 2022). While motivation is the drive to act, engagement is the actual participation and persistence in learning tasks (Aquino et al., 2024; Nindiasari & Samad, 2024; Papageorgiou et al., 2025). Research shows that emotional engagement is a strong predictor of mathematics achievement, although students often rate their behavioral engagement highest (Joshi et al., 2022; Maamin et al., 2022; Torrejos, 2024). Nontraditional teaching methods increase engagement and positive attitudes, fostering deeper cognitive involvement (Eltahir & Alsalhi, 2025; Yakar, 2023).

Research findings revealed that the overall level of academic achievement in MMW is only average, with the highest achievement occurring in the most concrete subtopic, like Patterns in Our World (Rodrigo & Prudente, 2024). However, even supportive environments may not fully overcome cognitive barriers, as high math anxiety and perceived difficulty can still undermine performance (Moroscallo, 2024). Low performance persists even when students hold positive attitudes, indicating that contextual factors and instructional quality play crucial roles in shaping actual achievement (Arifin et al., 2024; Irinco, 2025; Su, 2024).

Despite these persistent challenges, research also shows that positive classroom management affects learning outcomes by increasing student motivation and math engagement (Gutierrez Jr. & Doronio, 2024; Pondias & Tado, 2025). As reported in Nigeria, Tanzania, and the Philippines, classroom environment, culture, and inclusive strategies such as game-based indigenous games improve engagement, critical thinking, and performance while lowering math anxiety (Bercades & Cajandig, 2025; Demo et al., 2021; Mazana et al., 2020; Solomon, 2020). Highly motivated students also tend to work harder, overcome challenges, and perform better academically (Sujatha & Vinayakan, 2023).

Significantly, prior studies suggest that classroom environment and motivation influence mathematics performance indirectly by first shaping student engagement (Rajeh et al., 2023). A supportive environment may not directly raise test scores; rather, it fosters emotional and behavioral engagement, which in turn improves performance (Liu et al., 2026; Yang et al., 2021). Similarly, motivation translates into academic success largely through the learner's active engagement (Asare et al., 2024b; Obeng et al., 2025). This makes engagement a plausible mediating variable between the two predictors and the outcome. However, beyond simple mediation, the present study proposes a sequential mediation model wherein classroom environment and motivation operate through distinct pathways: classroom environment may first enhance student motivation, which then increases engagement, and ultimately improves mathematics performance. This sequenced pathway has not been previously examined in the context of Mathematics in the Modern World in a private higher education institution.

The private higher education institution under study operates a four-hectare campus with standard classrooms and serves 1532 students, with 473 first-year students across 13 sections of Mathematics in the Modern World (MMW). Based on preliminary institutional data obtained by the researcher, instruction is primarily lecture-based with occasional group work, and faculty demonstrate commitment to student learning despite limited access to content-specific professional development. The institution currently provides no formal remediation or tutoring programs, yet many first-year students demonstrate varying levels of mathematical preparedness, even though they possess low-to-average mathematical preparation. Recurring low quiz scores signal a persistent learning challenge, warranting an investigation into its possible causes. In this specific MMW context, mathematics performance is measured through an achievement test aligned with course learning outcomes.

Given these interrelated findings, it remains unclear whether classroom environment, motivation, and engagement operate in a sequential chain or as independent predictors in the specific context of Mathematics in the Modern World at private higher education institutions. The present study addresses this gap by testing a serial mediation model. Most existing literature examines these variables in isolation or at the secondary school level, leaving a significant gap in our understanding of tertiary learners in a private higher education institution. To address this gap, the present study examined a serial mediation model in which the classroom environment predicts student motivation, which in turn predicts engagement, and engagement ultimately predicts mathematics performance on the MMW. Specifically, this study sought to verify the serial mediation model of the relationships among classroom environment, motivation, student engagement, and mathematics performance.

Statement of the Problem

This study aimed to examine the relationships among classroom environment, student motivation, student engagement, and mathematics performance, specifically examining the sequential mediating roles of motivation and engagement in the link between classroom environment and mathematics performance.

Specifically, this study sought to answer the following questions:

1. What is the perceived mathematics classroom environment in terms of teacher support, student autonomy, satisfaction in learning mathematics, difficulty in learning, cooperation among students, competition among students, innovation of teaching, and classroom discipline among college students in a private higher education institution?
2. What is the perceived motivation in terms of intrinsic motivation, extrinsic motivation, and perception of mathematics among college students in a private higher education institution?
3. What is the perceived engagement in terms of behavioral, emotional, and cognitive engagement among college students in a private higher education institution?
4. What is the mathematics performance of college students in a private higher education institution?
5. Is there a significant relationship among mathematics classroom environment, motivation, engagement, and performance of college students in a private higher education institution?
6. Does the classroom environment have a significant indirect association with mathematics performance through the sequential mediation of motivation and engagement?

Hypotheses

In this study, the researcher hypothesized the following:

1. There is no significant relationship among mathematics classroom environment, motivation, engagement, and performance of college students in a private higher education institution.
2. Classroom environment has no significant indirect association with mathematics performance through the sequential pathway of motivation followed by engagement.

Framework

This study was grounded in four key theoretical perspectives: Classroom Environment Theory, Self-Determination Theory (SDT), Fredricks et al.'s Model of Engagement, and Classical Test Theory (CTT), which collectively explore the structural pathways of how the classroom environment, motivation, and engagement predict mathematics performance.

Fraser's Classroom Environment Theory supported the mathematics classroom environment, offering a robust model to evaluate psychosocial and physical classroom features and their effects on learning across subjects like mathematics (Fraser, 1998). Modern studies reaffirmed the critical role of a supportive, well-managed classroom environment in enhancing students' academic success and psychological well-being in mathematics (Ahmed & Pierre, 2024). Recent research emphasizes that teacher support, student autonomy, collaboration, and innovative teaching are critical dimensions for creating a positive learning climate that fosters motivation and engagement (Dalimunthe et al., 2024). Recent meta-analyses confirm that organized classroom environments characterized by supportive teacher activities, autonomy, and social collaboration enhance intrinsic motivation and cognitive engagement in mathematics (Bureau et al., 2022; Howard et al., 2024).

Conversely, barriers such as perceived learning difficulty and lack of discipline can negatively impact motivation and engagement, highlighting the need for targeted interventions (Rone et al., 2023). The classroom environment sets the psychosocial context, supporting the satisfaction of learners' psychological needs per SDT, which in turn fuels motivational processes leading to active engagement (Makaremi et al., 2024). Such environments pave the way for motivation to shape engagement and ultimate performance.

Self-Determination Theory (SDT) framed the motivation in mathematics, attributing it to meeting core needs for autonomy, competence, and relatedness that ignite intrinsic motivation and deeper cognitive participation (Bandhu et al., 2024; Ryan et al., 2025; Yang et al., 2025). Recent research has thoroughly substantiated Self-Determination Theory (SDT) across several educational contexts, highlighting its significance in mathematics education for promoting enduring motivation (Knopik & Oszwa, 2023; Wang et al., 2024). Recent evidence indicates that the enhancement of autonomy-supportive instructional methods and competence-building activities increases intrinsic motivation and self-regulated learning in higher education (Brandisauskiene et al., 2023; Mirzaei et al., 2025; Wang et al., 2025). This motivation then channels into engagement, mediating its link to performance.

Fredricks et al.'s Model of Engagement conceptualized mathematics engagement as a fluid, multifaceted phenomenon involving emotional, behavioral, and cognitive facets (Papageorgiou et al., 2025). The idea of engagement is dynamic, ever-changing, and multidimensional, with three primary dimensions: emotional, cognitive, and behavioral (Alrashidi et al., 2016). In addition, engagement is strongly linked to motivational factors such as self-efficacy, which boost students' cognitive and emotional engagement in learning, suggesting that students who are confident in their math abilities are more likely to engage thoroughly, leading to improved learning and academic success (Reeve et al., 2022). Notably, engagement acts as a mediator between classroom environment, motivation, and mathematics performance.

Mathematics Performance was grounded on Classical Test Theory (CTT), viewing observed scores as a true score combined with random error (Hu et al., 2021). This theory was employed to assess content-related validity evidence, reliability, difficulty indices, discrimination indices, and distractor analysis for the test items (Gyamfi, 2022). Applying this theory, the study justifies employing standardized achievement scores as the endogenous variable, which represents students' true competency level in Mathematics in the Modern World.

Together, these four frameworks define a clear sequential pathway: classroom environment shapes the learning context (Fraser), satisfies psychological needs that generate motivation (SDT), translates motivation into observable engagement (Fredricks et al.), and reliably measures true mathematics competency (CTT). Fraser's Classroom Environment Theory provides the classroom-level conditions that shape the learning context. Self-Determination Theory explains why these conditions satisfy students' psychological needs for autonomy,

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competence, and relatedness, thereby generating motivation. Fredricks et al.'s model of engagement then shows how motivation translates into observable behavioral, emotional, and cognitive engagement. Finally, Classical Test Theory assures that the achievement test reliably captures true mathematics competency. Thus, the four theories jointly support a sequential mediation mechanism: a supportive environment fosters motivation, motivated students become engaged, and engaged learners achieve higher performance.

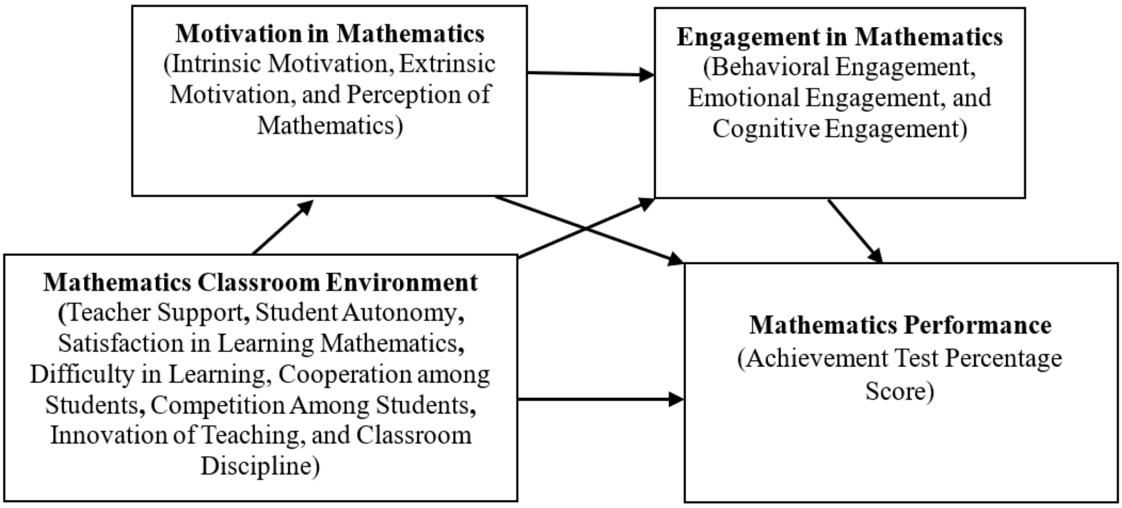

Figure 1. **Schematic Diagram of the Serial Mediation Model**

The schematic diagram presents a conceptual and structural model illustrating the serial mediation pathways among the independent, mediating, and dependent variables based on Hayes' Model 6 (Hayes, 2013). The model initiates with a single independent variable on the left: the mathematics classroom environment. This construct is multifaceted, consisting of teacher support, student autonomy, satisfaction, difficulty, cooperation, competition, innovation, and classroom discipline.

Following the independent variable, the model specifies two mediating variables in a sequence. The first mediator is motivation in mathematics, categorized into intrinsic motivation, extrinsic motivation, and students' general perception of mathematics. The second mediator is engagement in mathematics, encompassing behavioral, emotional, and cognitive dimensions. Arrows represent hypothesized directional relationships based on theory, not causal effects.

The model culminates on the right with the dependent variable, mathematics performance, operationalized through achievement test percentage scores. Paths include: (a) classroom environment → motivation, (b) motivation → engagement, (c) engagement → performance, (d) direct path from classroom environment → engagement, (e) direct path from classroom environment → performance, and (f) direct path from motivation → performance. This specification allows for the estimation of the sequential indirect effect (environment → motivation → engagement → performance) alongside direct and other indirect paths. All paths are interpreted as associations with assumed temporal ordering for statistical mediation testing. The model tests whether the indirect association (Classroom Environment → Motivation → Engagement → Performance) is statistically significant. By evaluating these multiple pathways simultaneously, the diagram serves as the structural blueprint for the serial mediation analysis.

Significance

This study on the mathematics classroom environment, motivation, engagement, and performance among college students at a private higher education institution is significant to the educational community of the target institution. The findings may provide valuable insights for various stakeholders, from institutional leaders to students, and may contribute to the improvement of mathematics education. Specifically, this study may be significant to the following:

School Administrators

This study may assist school administrators, particularly the Vice President for Academic Affairs, in identifying classroom environment factors that influence students' motivation, engagement, and performance in mathematics. The findings may serve as a basis for decisions regarding resource allocation, instructional support, and professional development initiatives aimed at fostering a positive and effective learning environment, thereby enhancing student achievement and institutional quality.

Program Coordinators

This study may help program coordinators design targeted professional development programs for instructors of Mathematics in the Modern World. The findings may enable them to identify specific aspects of the classroom environment that require improvement and to implement strategies that enhance student motivation, engagement, and academic performance.

Mathematics Instructors

This study may assist mathematics instructors in identifying classroom environment characteristics that influence students' motivation, engagement, and performance. Such understanding may help instructors refine their teaching practices, adopt more student-centered instructional approaches, and implement appropriate classroom interventions that foster a supportive learning atmosphere and encourage active participation in mathematical activities.

College Students

This study may help college students recognize factors that influence their learning experiences in mathematics. Increased awareness of these factors may encourage them to participate more actively in class, seek academic support when needed, adopt effective learning strategies, and develop greater confidence in mathematics, thereby improving their academic performance.

Researcher

This study may enable the researcher to gain a deeper understanding of the relationships among the mathematics classroom environment, motivation, engagement, and performance of college students. The knowledge generated may serve as a foundation for future research and educational interventions within the institution.

Future Researchers

Future researchers may benefit from this study as it provides empirical evidence regarding the relationships among the mathematics classroom environment, motivation, engagement, and performance of college students. The findings may serve as a reference for subsequent investigations that seek to explore additional variables and develop strategies for improving mathematics learning experiences and outcomes.

Scope and Limitation

This study focuses on first-year college students enrolled in Mathematics in the Modern World at a private higher education institution in the First Congressional District of Negros Occidental during Academic Year 2025–2026. The study examines the mathematics classroom environment through eight dimensions, motivation through three dimensions, and engagement through three dimensions using self-report survey instruments. Mathematics performance is measured through a 30-item achievement test. Data collection and analysis were conducted over ten months, from August 2025 to May 2026.

Several limitations warrant consideration. First, the cross-sectional design precludes causal claims; all mediation effects are interpreted as correlational and theory-driven associations, not causal relationships. Second, self-reported perceptions may be influenced by social desirability or recall bias. Third, the single-institution sample limits generalizability to other private or public higher education institutions. Fourth, the achievement test covers only MMW topics and may not reflect long-term retention. Fifth, the study did not control for prior mathematics knowledge, instructor differences, or teaching strategies.

Definition of Terms

The following key terms are defined both conceptually and operationally:

Academic Program

Conceptually, it refers to a structured sequence of courses designed to achieve a specific qualification, such as a degree, certificate, diploma, or license, and is identified by a unique institutional code (Kalu & Salahuddin, 2022). Operationally, it refers to the specific degree program offered by the school where the study was being conducted and serves as a demographic grouping variable in the study.

Classroom Environment

Conceptually, classroom environment encompasses the physical setting, social interactions, and instructional practices that collectively shape the learning climate and influence student engagement and teaching effectiveness (Ahmed et al., 2020). Operationally, it is one of the variables being studied and assessed using an adapted survey questionnaire that focuses on the perceived mathematics classroom environment, including teacher support, student autonomy, satisfaction in mathematics, student cooperation, teaching innovation, and classroom discipline.

Teacher Support. Conceptually, teacher support refers to the multidimensional construct comprising teachers' attitudes and behaviors that promote students' academic success and holistic development (Shao et al., 2025). Operationally, it refers to one of the dimensions under the mathematics classroom environment, which assesses the degree to which the instructor is approachable, helpful, fair, communicative, considerate, and encouraging toward students

Student Autonomy. Conceptually, student autonomy refers to a multidimensional skill enabling students to take responsibility for their own learning process actively (Rivera-Gómez-Barris & El Homrani Maknuzi, 2025). Operationally, it refers to one of the dimensions under the mathematics classroom environment that evaluates the degree to which students are given the freedom to make choices, pursue interests, and control the pace and process of their own learning.

Satisfaction in Learning. Conceptually, satisfaction in learning refers to a positive psychological state resulting from students' perceptions and evaluations of their educational experiences and outcomes (Qin et al., 2025). Operationally, it refers to one of the dimensions under the mathematics classroom environment that assesses the degree to which students feel enjoyment, confidence, and overall fulfillment in their Mathematics in the Modern World learning experience.

Difficulty in Learning. Conceptually, difficulty in learning refers to a condition in the learning process characterized by specific obstacles that hinder students from achieving expected learning outcomes (Baiti et al., 2024). Operationally, it refers to one of the dimensions of the mathematics classroom environment that assesses the extent to which students experience challenges in understanding lessons, completing tasks, and responding to questions in the Mathematics in the Modern World course.

Cooperation. Conceptually, cooperation refers to a pedagogical and relational process in which students collaborate in small groups to maximize individual and mutual learning toward achieving shared learning objectives (Nguyen & Oanh, 2025). Operationally, it refers to one of the dimensions under the mathematics classroom environment that assesses the degree to which students assist, share resources, collaborate, and learn together to accomplish learning tasks and goals.

Competition. Conceptually, competition refers to an interactive process or social structure in which students work independently or in groups on the same task to earn rewards or recognition based on their relative performance (Mcguire & Mcguire, 2025). Operationally, it refers to one of the dimensions under the mathematics classroom environment that evaluates the degree to which students compare performance, strive to outperform peers, and perceive a competitive classroom environment.

Teaching Innovation. Conceptually, teaching innovation refers to the ability to personalize learning, foster creativity, and use data to inform instructional decisions (Salvacion, 2025). Operationally, it refers to one of the dimensions under the mathematics classroom environment that assesses the degree to which the instructor uses creative methods, plans innovative activities, and encourages and recognizes students' creativity in learning.

Classroom Discipline. Conceptually, classroom discipline refers to a professional practice and a situation in which teachers and students accept and consistently follow a set of rules governing classroom behavior (Gagaramusu et al., 2026). Operationally, it refers to one of the dimensions under the mathematics classroom environment that evaluates the degree to which the class is well-organized, rules are followed, behavior is appropriate, and expectations are clearly communicated.

Mediating Variables

Conceptually, mediating variables refer to the intermediate variable through which an independent variable exerts its effect on a dependent variable (Kim & Lee, 2021). Operationally, these refer to the motivation and engagement in mathematics.

Motivation

Conceptually, motivation refers to the internal drive that initiates, directs, and sustains students' learning behaviors, influenced by both intrinsic satisfaction and external rewards to achieve academic goals (Davidovitch & Dorot, 2023). Operationally, it is one of the exogenous variables that was being studied and assessed through an adapted survey questionnaire, which is focused on the perceived motivation of students in mathematics in terms of intrinsic, extrinsic, and perception of mathematics.

Intrinsic Motivation. Conceptually, intrinsic motivation refers to activities undertaken for their own sake, driven by inherent interest and enjoyment (Balayo & Plaza, 2025). Operationally, it is one of the dimensions of motivation that evaluates students' self-driven interest and personal satisfaction in Mathematics in the Modern World, demonstrated by voluntarily studying, practicing, and exploring mathematical content beyond required tasks.

Extrinsic Motivation. Conceptually, extrinsic motivation refers to the behavior driven by external factors such as rewards or the avoidance of punishment (Isıkgoz, 2025). Operationally, it is one of the dimensions of motivation that assesses the students' interest driven by external goals, rewards, or perceived academic benefits.

Perception of Mathematics. Conceptually, perception of mathematics refers to how students personally view mathematics as a subject, including their feelings and thoughts about learning it (Daud et al., 2020). Operationally, it is one of the dimensions of motivation that evaluates students' beliefs, interests, and confidence in the value, usefulness, and learnability of Mathematics in the Modern World.

Performance

Conceptually, performance refers to the learned abilities or competencies students acquire from lessons, measured through teacher-made tests to evaluate learning gains (Abalde & Oco, 2023). Operationally, it refers to the students' achievement test percentage scores.

Engagement

Conceptually, engagement can be defined as the integration of cognitive, emotional, and affective strategies in interpretative exchanges (Tay et al., 2021). Operationally, it is one of the exogenous variables that was being studied and assessed through an adapted survey questionnaire, which is focused on the perceived engagement of students in mathematics in terms of behavioral, emotional, and cognitive engagement.

Behavioral Engagement. Conceptually, behavioral engagement refers to the degree to which students actively participate in learning activities, such as listening and reading attentively and participating in class discussions (Wang et al., 2025). Operationally, it is one of the dimensions of engagement that evaluates students' active participation, effort, and persistence in learning tasks in Mathematics in the Modern World.

Emotional Engagement. Conceptually, emotional engagement refers to the emotions generated by learning situations, including positive emotions and negative emotions (Zimmerman et al., 2025). Operationally, it is one of the dimensions of engagement that assesses students' positive feelings, enjoyment, and excitement while learning Mathematics in the Modern World.

Cognitive Engagement. Conceptually, cognitive engagement refers to the psychological investment students make in learning, ranging from memorization to using self-regulatory strategies to achieve deep understanding (Barlow et al., 2020). Operationally, it is one of the dimensions of engagement that evaluates students' mental effort and strategic thinking in understanding, applying, and solving problems in Mathematics in the Modern World.

METHODOLOGY

This chapter outlines the research design, locale, respondents, instrument, validity and reliability, data collection, data analysis, and ethical considerations.

Research Design

This study employed a descriptive, cross-sectional correlational design. Descriptive research outlines the attributes of a specific population or phenomenon, focusing on what is happening rather than why (Manjunatha, 2021). A descriptive research design was suitable for assessing levels of mathematics classroom environment, motivation, engagement, and performance among college students.

A cross-sectional study measures exposures and outcomes at the same point in time, providing a "snapshot" of variables without longitudinal follow-up (Eltayeb et al., 2025; Prabhakar & Kaushal, 2024). In this study, all variables were collected at a single time point, consistent with a cross-sectional approach. A correlational design evaluates relationships between two or more variables without modifying the data (Putri et al., 2025). A correlational research design was ideal for examining the relationship among classroom environment, motivation, engagement, and performance in mathematics of college students in a private higher education institution.

Research Locale

The study was conducted in a private higher education institution located in the first congressional district of Negros Occidental, Philippines, approximately ninety-six kilometers from Bacolod City, the provincial capital. Founded in 1961, the school offers various baccalaureate programs in teacher education, business administration, information technology, and liberal arts. It serves college students from the city, municipality, and surrounding rural areas, many of whom come from families with limited economic resources. Accessible by land transportation, the institution is one of the primary higher education providers in the locality and was selected as the research site due to its relevance to the study's objectives and the accessibility of respondents meeting the required inclusion criteria.

Research Respondents

In statistics, the population refers to the total group from which data are collected and analyzed (Momoh, 2025). The respondents were first-year college students from a private higher education institution who enrolled in Mathematics in the Modern World in Academic Year 2025-2026, and who willingly provided consent to participate. A sample size of 342 was determined using the G*Power priori sample size calculator. This calculation incorporated an anticipated effect size of 0.051, statistical power of 0.95, probability level of 0.05, and three predictors.

The study employed stratified random sampling. In stratified sampling, the researcher divides a heterogeneous population into homogeneous subgroups (strata) based on key characteristics, ensuring each member belongs to one stratum to proportionally represent population diversity and minimize sampling error. (Thomas, 2023). To ensure that every academic program is well-represented, the researcher designated the academic programs as the strata and computed the sample size for each stratum, as seen in Table 1.

After determining the sample for each stratum, the respondents were picked randomly using a random number generator to ensure that there would be no bias in sampling. The researcher requested from the registrar's office the list of students, arranged them alphabetically, and determined the respondents based on the generated random number. The list of students was stored securely, accessed only by the researcher, and was deleted immediately after the sample of respondents was finalized. The information was not used for any purpose other than the sampling process for this study.

Table 1 The Distribution of the Sample Size in terms of Academic Program

Academic Program	***N***	***n***
A	219	158
B	67	48
C	40	29
D	74	54
E	29	21
F	19	14
G	25	18
Total	**473**	**342**

Instruments

This study employed a structured survey questionnaire for the three latent variables and an achievement test to assess the mathematics performance. The instrument consists of three parts. Part I focused on the profile of the respondents in terms of academic program. This variable was included to provide a clear description of the respondents and to serve as a basis for sampling.

Part II measured the exogenous and endogenous variables of the study. The mathematics classroom environment scale, which was modified from Yin and Lu (2014), measures how students feel about their teachers' support, their autonomy, how much they enjoy learning mathematics, how cooperative their peers are, how innovative their teachers are, and how disciplined the classroom is. The motivation scale evaluated students' perceptions of mathematics as well as internal and extrinsic motivation. It was adapted from Nurkarim et al. (2023). The engagement assessed behavioral, emotional, and cognitive engagement and is adapted from Flores et al. (2021). A four-point Likert-type scale was used for each item in Part II to assess respondents' level of agreement without utilizing a neutral middle point, which encourages more thoughtful answers.

Part III is an achievement test in Mathematics in the Modern World, designed to measure the academic performance of the respondents. The test consists of 30-item multiple-choice questions covering key topics prescribed in the course syllabus, such as patterns and sequences, sets and functions, inductive and deductive reasoning, problem-solving strategies, and basic statistics. The achievement test was based on the official course syllabus of the institution and aligned with CHED Memorandum Order (CMO) No. 20 series of 2013, ensuring that the test items are consistent with national standards, course learning outcomes, and the intended competencies of the subject. Based on the TOS, a specified number of multiple-choice items were developed for each content area and cognitive level. All items were written to match the learning objectives stated in the syllabus and were reviewed for clarity, appropriateness of difficulty, and alignment with the intended learning outcomes.

Validity

Validity is important in selecting an instrument for a research study (Roebianto et al., 2023; Rodenas, 2025). Content validity assesses the extent to which an instrument comprehensively includes all relevant aspects of the theoretical concept or idea it intends to measure, especially those that cannot be directly observed (Nikolopoulou, 2023). This study used Lawshe's content validity ratio (CVR) to determine the validity of the research instrument. It involved a panel of eleven (11) validators, where six of them are experts in teaching the course Mathematics in the Modern World. The validators rated each item of the survey instrument and the achievement test as "essential", "useful but not essential," or "not essential." Items rated as "essential" were coded as three (3), "useful but not essential" as two (2), and "not essential" as one (1). Then, the researcher computed the CVR for each item using Microsoft Excel. Items with a CVR $\geq$ 0.636 were included in the final research instrument, which would be tested for reliability (Ayre & Scally, 2015).

Initially, the instrument consisted of 100 items across three domains: Mathematics Classroom Environment, Motivation, and Engagement. Following expert validation, 29 items were rejected for failing to meet the essentiality threshold, resulting in a refined 71-item questionnaire. The final instrument achieved a Content Validity Index (CVI) of 0.948, with domain-specific ratios of 0.939 (Classroom Environment), 0.964 (Motivation), and 0.941 (Engagement). These high CVI values indicate a strong consensus among validators that the remaining items are essential and representative of the constructs being measured.

Separately, the 45-item achievement test was validated by a sub-panel of six mathematics experts from the original group. This instrument yielded a perfect CVI of 1.00, with unanimous agreement and no items rejected. All qualitative feedback from the validators was integrated into the final copy of both instruments before the reliability testing.

Reliability

Reliability, on the other hand, is the consistency of a measurement method, demonstrated when it yields the same results repeatedly under identical conditions (Middleton, 2019; Rodenas & Menes, 2026). Cronbach's coefficient alpha is a commonly used measure of internal consistency (Kennedy, 2022). Another is the Kuder-Richardson Formula 20 (KR-20), which serves as a reliability coefficient specifically designed to evaluate the internal consistency of tests comprising dichotomous response items, thereby assessing the degree to which test items measure the same underlying construct (Ntumi et al., 2023). The 71-item survey questionnaire achieved an overall Cronbach's alpha of 0.944, with individual scales for mathematics classroom environment (a= 0.918), motivation in mathematics (a= 0.907), and engagement in mathematics (a= 0.892) all showing strong reliability. For the achievement test, 15 items were rejected following validation to refine the assessment, resulting in a final 30-item test with a KR-20 coefficient of 0.798.

Data Collection

After establishing the validity and reliability, the researcher produced the final copy of the instrument in hard copies. Permission to conduct the research had been secured by asking for approval from the school president through the Vice President for Academic Affairs. The researcher was personally asked for consent and distributed the consent form to the respondents. The researcher described the goal of the study and responded to inquiries from the students. The researcher scheduled the administration of the questionnaire in a way that did not adversely affect the respondents' work or study.

During the scheduled date, questionnaires were distributed, and the respondents were informed to complete them within one and a half (1.5) hours. Afterwards, the researcher gathered and tabulated the data through Microsoft Excel. Then, it was imported into the Jamovi software for analysis. Printed materials were secured in a locked cabinet, and electronic data were stored in password-protected files on a secure laptop. Records were kept for six (6) months until the completion of the study, followed by secure destruction through shredding of paper files and permanent deletion of digital files.

Data Analyses

The following statistical methods were used in this study to investigate the relationship between college students' performance, motivation, engagement, and the mathematics classroom environment at a private higher education institution.

For problems 1 to 4, descriptive statistical measures were employed. Means and standard deviations were computed for each variable and its corresponding dimensions, providing a general overview of students' perceptions, experiences, and performance in mathematics and serving as the basis for subsequent analyses. The mean interval was adopted from the study of Pornel (2013).

For the mathematics classroom environment among college students in a private higher education institution, the mean is interpreted as shown in Table 2.

Table 2 Interpretation Scale for the Mathematics Classroom Environment, Motivation, and Engagement

Mean Interval	Description	Verbal Interpretation
3.50-4.00	Very High	A very high perceived quality of the mathematics classroom environment, motivation, and engagement among college students at a Private Higher Education Institution.
2.50-3.49	High	A high perceived quality of the mathematics classroom environment, motivation, and engagement among college students at a Private Higher Education Institution.
1.50-2.49	Low	A low perceived quality of the mathematics classroom environment, motivation, and engagement among college students at a Private Higher Education Institution.
1.00-1.49	Very Low	A very low perceived quality of the mathematics classroom environment, motivation, and engagement among college students at a Private Higher Education Institution.

For the performance in mathematics among college students in a private higher education institution, the scale was adapted from Padawag (2025) and interpreted as shown in Table 3.

Table 3 Interpretation Scale for the Performance in Mathematics

Mean Interval	Description	Verbal Interpretation
90-100%	Outstanding Performance	An outstanding performance in mathematics among college students in a Private Higher Education Institution.
85-89%	Very satisfactory Performance	A very satisfactory performance in mathematics among college students in a Private Higher Education Institution.

80-84%	Satisfactory Performance	A satisfactory performance in mathematics among college students in a Private Higher Education Institution.
76-79%	Fairly satisfactory Performance	A fairly satisfactory performance in mathematics among college students in a Private Higher Education Institution.
Below 75%	Did not meet Expectations	The performance in mathematics among college students in a Private Higher Education Institution did not meet expectations.

For problem 5, the researcher used Pearson's correlation to determine the relationships among the mathematics classroom environment, motivation, engagement, and the performance of college students at a private higher education institution.

For problem 6, mediation analysis was conducted using Jamovi with the 'jAMM' module to determine that perceived student engagement plays a mediating role concerning both the mathematics classroom environment and motivation towards mathematics performance. An analysis of the direct path was also done to identify direct relationships among the mathematics classroom environment, motivation, and engagement towards mathematics performance.

Ethical Consideration

In conducting a study on the mathematics classroom environment, motivation, engagement, and performance among college students in a private higher education institution, several ethical considerations are essential to maintain the study's integrity and protect the respondents.

Social Value

This research advanced educational practices and performance for college students by offering insights into effective strategies to enhance the mathematics classroom environment, motivation, and engagement. This includes developing the best-fit model that would explain the relationship of the variables to address learning disparities, motivation, and supporting instructors in fostering environments conducive to student engagement, particularly in a course like Mathematics in the Modern World that often poses challenges for students.

Informed Consent

The researcher sought informed consent from the school's president through an approval letter duly signed by the researcher, adviser, and the program head of the graduate school. Then, the researcher sent a clear consent form to the students. This consent describes the research's purpose, risks, and benefits so that everyone involved understands the study, agrees voluntarily, and can withdraw without any consequences at any point.

Risk and Benefits

The study minimized any potential risks, such as stress or anxiety, concerning participation. The benefits, such as improved mathematics classroom environment, motivation, engagement, and performance of college students, outweigh the risks.

Privacy and Confidentiality

Ensuring the confidentiality of student data is paramount. Personal identifiers were removed or anonymized to protect students' privacy. Data were securely stored and were only accessible to authorized personnel.

Justice

The research design ensured fair treatment of all respondents and avoided any form of bias or discrimination. It aimed to address inequalities in educational outcomes by identifying specific group needs.

Transparency

The research process, findings, and how data would be used should be transparently communicated to all stakeholders, including respondents, educators, and administrators.

Adequacy of Facilities

The research was carried out in the classroom, which provides a safe and conducive environment for the respondents. This includes ensuring that surveys are conducted in a manner that does not disrupt the learning process.

RESULTS AND DISCUSSIONS

This chapter summarized key results and discussions in tables, explores study implications, and reviews supporting literature. Data analysis offers descriptive insights into the mathematics classroom environment, motivation, engagement, and performance among college students in a private higher education institution. It further examines relationships and mediation effects among these variables.

Perceived Mathematics Classroom Environment

The descriptive statistics on students' perceived mathematics classroom environment across several dimensions are shown in Table 4. The overall results indicate that the perceived classroom environment is high (M = 3.14, SD = 0.30), suggesting that students generally experience a positive and supportive learning context in mathematics. Among the specific dimensions, teacher support (M = 3.36, SD = 0.49) and classroom discipline (M = 3.35, SD = 0.47) obtained the highest mean scores, both interpreted as high, indicating that instructors are perceived as supportive and that classroom management is effectively maintained.

Similarly, student autonomy (M = 3.34, SD = 0.42), cooperation among students (M = 3.28, SD = 0.43), and innovation in teaching (M = 3.28, SD = 0.54) were also rated high, reflecting that students are given opportunities for independent learning, collaborative engagement, and exposure to creative instructional strategies. In terms of satisfaction in learning mathematics, a high rating (M = 3.13, SD = 0.53), suggesting that students generally find their learning experiences fulfilling. Notably, difficulty in learning mathematics (M = 2.94, SD = 0.57) and competition among students (M = 2.64, SD = 0.61) also fell within the high interpretation range, implying that while students perceive the environment positively, they still encounter moderate levels of academic challenge and competitive dynamics.

Table 4 Descriptive Statistics on the Perceived Mathematics Classroom Environment Among College Students in a Private Higher Education Institution

Variable	M	Interpretation	SD
Teacher Support	3.36	High	0.49
Student Autonomy	3.34	High	0.42
Satisfaction in Learning	3.13	High	0.53
Difficulty in Learning	2.94	High	0.57
Cooperation Among Students	3.28	High	0.43
Competition Among Students	2.64	High	0.61
Innovation in Teaching	3.28	High	0.54
Classroom Discipline	3.35	High	0.47
Overall	**3.14**	**High**	**0.30**

Note. N=342. M = Mean. SD = Standard Deviation. The interpretation scale is based on a 4-point Likert-type scale: 3.50–4.00 (Very High), 2.50–3.49 (High), 1.50–2.49 (Low), and 1.00–1.49 (Very Low).

The results indicate that a well-supported and well-managed classroom environment significantly enhances students' mathematics learning experiences. High levels of teacher support and classroom discipline suggest that students benefit from clear guidance, structured instruction, and positive teacher-student relationships. This suggests that educators should continue to strengthen these aspects by maintaining organized classroom routines, providing timely and constructive feedback, and fostering an atmosphere where students feel encouraged to participate and engage.

At the same time, the presence of high levels of student autonomy and satisfaction indicates that incorporating learner-centered approaches can further promote motivation and active involvement in the learning process. The results also suggest that a positive classroom environment alone may not be sufficient to fully address the challenges students face in learning mathematics. The observed difficulty in learning the course implies that some students may still struggle with conceptual understanding or experience cognitive and emotional barriers. This calls for the implementation of more targeted instructional strategies, such as differentiated instruction, scaffolding, and additional academic support, to meet diverse learning needs.

Furthermore, the relatively lower perception of competition indicates the importance of maintaining a balanced classroom dynamic that emphasizes collaboration while still providing appropriate academic challenges. These implications point to the need for a holistic approach that combines supportive teaching, structured management, and responsive instructional practices to optimize students' mathematical learning outcomes.

The findings are consistent with previous studies stressing the multidimensional function of the classroom environment in mathematics teaching. Asare et al. (2024) found that effective classroom management and student passion are strong predictors of mathematical achievement. Similarly, Soe et al. (2025) argued that teacher autonomy support meets core psychological requirements, hence increasing intrinsic motivation and longitudinal achievement in mathematics. Teacher support has a significant positive impact on student mathematical proficiency (Zhang, 2025).

In contrast, Onen & Ayiorwoth (2025) suggested that despite strong institutional intent, systemic barriers such as insufficient teacher preparation and huge class numbers frequently impede the actual success of creative teaching in private schools. Furthermore, Moroscallo (2024) presented a contrasting perspective, claiming that high levels of subject difficulty and math anxiety can harm performance even in environments perceived as supportive, showing that environmental positive perceptions alone cannot fully compensate for cognitive and psychological barriers.

The findings on student cooperation and innovation in teaching provide additional support for Fraser's Classroom Environment Theory, which emphasizes that collaborative learning and creative instructional strategies contribute to a positive psychosocial climate that enhances learning outcomes (Fraser, 1998). Furthermore, the high satisfaction rating in learning mathematics aligns with recent meta-analyses confirming that organized classroom environments characterized by autonomy and social collaboration enhance intrinsic motivation and cognitive engagement in mathematics (Bureau et al., 2022; Howard et al., 2024). The relatively lower perception of competition further supports the theoretical notion that excessive competition may undermine relatedness and intrinsic motivation, whereas a balanced classroom dynamic emphasizing collaboration promotes more sustainable engagement (Makaremi et al., 2024).

In other words, these findings indicate that, while a supportive and well-structured environment is essential, achieving full mathematical competence requires a comprehensive approach that balances positive environmental perceptions with specific measures to address the topic's essential cognitive and psychological requirements.

Perceived Motivation in Mathematics

The descriptive statistics on the perceived motivation among college students at a private higher education institution are presented in Table 5. The results indicated high motivation among the participants, with a composite mean score of 3.14 (*SD* = 0.43). When examining the specific dimensions, extrinsic motivation yielded the highest mean score of 3.21 (*SD* = 0.46), followed by perception of mathematics with a mean of 3.16 (*SD* = 0.48). Intrinsic motivation received the lowest mean score of the three dimensions, at 3.04 (*SD* = 0.50). All three dimensions reported high motivation in mathematics.

The findings indicate that while college students maintain a strong overall drive to learn mathematics, their primary motivation is extrinsic, suggesting they are largely influenced by external rewards such as grades, awards, or compliments. This reliance on external factors implies that while students are likely to remain diligent and perform well, there is a need for instructional strategies that spark deeper personal curiosity to ensure long-term engagement. These results suggest that the private higher education institution has successfully motivated its students through clear goals and high standards, but further efforts could be made to help students find more internal satisfaction in their mathematical studies.

Table 5 Descriptive Statistics on the Perceived Motivation Among College Students in a Private Higher Education Institution

Variable	***M***	***Interpretation***	***SD***
Intrinsic Motivation	3.04	High Motivation	0.50
Extrinsic Motivation	3.21	High Motivation	0.46
Perception of Mathematics	3.16	High Motivation	0.48
Overall	**3.14**	**High Motivation**	**0.43**

Note. N=342. *M* = Mean. *SD* = Standard Deviation. The interpretation scale is based on a 4-point Likert-type scale: 3.50–4.00 (Very High Motivation), 2.50–3.49 (High Motivation), 1.50–2.49 (Low Motivation), and 1.00–1.49 (Very Low Motivation).

Recent research supports the finding that extrinsic motivation is an effective motivating factor for academic achievement and behavioral engagement in mathematics (Hidayatullah et al., 2024). This result indicates that while intrinsic motivation may be low, well-structured extrinsic techniques effectively maintain student diligence and sustain consistent academic performance across complex subject matter (Ridhuan et al., 2025). Other research, however, argues that students who feel truly motivated outperform those who rely on external rewards in terms of academic performance and learning attitudes (Shuaili, 2025). While extrinsic factors can effectively lay the foundation for diligence and discipline, building intrinsic interest is essentially necessary for greater performance and a more resilient strategy for learning. To put it simply, these results indicate that, while extrinsic motivators can successfully motivate academic dedication in mathematics, developing a stronger sense of intrinsic value is still necessary for sustaining long-term interest and cognitive engagement.

Perceived Engagement in Mathematics

The descriptive statistics for perceived student engagement at a private higher education institution are shown in Table 8. The students reported a high level of engagement, with a composite mean score of 3.27 (*SD* = 0.41). Among the specific dimensions, behavioral engagement showed the highest mean at 3.37 (*SD* = 0.42), followed by cognitive engagement with a mean of 3.28 (*SD* = 0.47). Emotional engagement received the lowest mean score of 3.15 (*SD* = 0.54). All dimensions fall within the high engagement in mathematics.

Table 6 Descriptive Statistics in the Perceived Engagement Among College Students in a Private Higher Education Institution

Variable	***M***	**Interpretation**	***SD***
Behavioral Engagement	3.37	High Engagement	0.42
Emotional Engagement	3.15	High Engagement	0.54

Cognitive Engagement	3.28	High Engagement	0.47
Overall	**3.27**	**High Engagement**	**0.41**

Note. N=342. *M* = Mean. *SD* = Standard Deviation. The interpretation scale is based on a 4-point Likert-type scale: 3.50–4.00 (Very High Engagement), 2.50–3.49 (High Engagement), 1.50–2.49 (Low Engagement), and 1.00–1.49 (Very Low Engagement).

The high overall engagement level shows that students are highly engaged in the Mathematics in the Modern World course, with a high preference for Behavioral Engagement. This highest result implies that students are highly diligent about following instructions, participating in discussions, and working through problem-solving errors until they are solved. Furthermore, the high levels of Cognitive Engagement imply that learners are not simply passive recipients of information, but are actively applying strategic thinking and actively trying to relate mathematical concepts to real-world problems. While Emotional Engagement is slightly lower, it implies that students may find the subject matter less interesting or exciting than their behavioral efforts, they are still genuinely interested in the learning experience.

The finding that students reported high overall motivation in mathematics is consistent with Self-Determination Theory, which explains that motivation is driven by the satisfaction of core needs for autonomy, competence, and relatedness (Ryan & Deci, 2020). The high extrinsic motivation score aligns with recent evidence indicating that autonomy-supportive instructional methods and competence-building activities increase motivation in higher education mathematics (Brandisauskiene et al., 2023; Mirzaei et al., 2025). The lower intrinsic motivation score suggests that students' psychological needs may not be fully satisfied, as Self-Determination Theory posits that intrinsic motivation flourishes only when autonomy, competence, and relatedness are adequately supported (Bandhu et al., 2024). The moderately high perception of mathematics indicates that students do not hold negative views of the subject, which is important because positive perceptions of mathematics are linked to enduring motivation and self-regulated learning (Wang et al., 2025).

A study by Torrejos (2024) supported the findings, showing that emotional engagement had a lower mean than behavioral and cognitive engagement. Another study reported a high behavioral, social, emotional, and cognitive engagement during online instruction (Joshi et al., 2022). However, a study by Maamin et al. (2022) found that emotional engagement is the strongest predictor of mathematical achievement.

In other words, these results indicate that even though students show remarkable dedication and strategic effort in their mathematics courses, improving the curriculum's emotional and enjoyable aspects could further increase their general engagement and sustained interest in the topic.

Mathematics Performance of College Students

As shown in Table 9, college students' mathematics performance in a private higher education institution was satisfactory (*M* = 79.46%, *SD* = 13.49), indicating that the average score fell within the 76–79% range, which is interpreted as Fairly Satisfactory.

Table 9 Descriptive Statistics in the Mathematics Performance of College Students in a Private Higher Education Institution

Variable	***M***	**Interpretation**	***SD***
Mathematics Performance	79.46	Fairly Satisfactory Performance	13.49

Note. M = Mean; *SD* = Standard Deviation. The interpretation scale is based on a mean percentage score: 90-100% (Outstanding Performance), 85-89% (Very Satisfactory Performance), 80-84% (Satisfactory Performance), 76-79% (Fairly Satisfactory Performance), and below 75% (Did not meet expectation).

While this fairly satisfactory performance suggests that students are generally meeting baseline expectations, it nonetheless reveals a notable gap given that, as reported earlier in this chapter, students perceived their classroom environment as highly supportive and described themselves as strongly motivated and behaviorally engaged. This gap implies that, although the classroom climate is helpful and students are following instructions and participating actively, their efforts may be translating only into surface-level learning rather than deep conceptual understanding of mathematics. The cognitive demands of the "Mathematics in the Modern World" curriculum may be outstripping many students' existing foundational skills, preventing them from reaching satisfactory, very satisfactory, or outstanding levels despite their positive attitudes and behavioral compliance.

Consequently, these findings indicate that a positive classroom environment and high student motivation alone are insufficient; more scaffolded instructional support and targeted interventions are necessary to bridge the divide between student engagement and the rigorous technical demands of course assessments.

Research on student performance in Mathematics in the Modern World presents conflicting views, with some evidence supporting the findings that students have low interest and poor computational skills (Carbonel et al., 2022; Harold et al., 2025) , whereas some suggest students maintain positive attitudes and satisfactory achievement (Irinco, 2025). These different outcomes show that particular educational environments likely have an impact on students' performance and perception (Arifin et al., 2024; Su, 2024).

Relationship Among the Variables

A Pearson product-moment correlation was conducted to examine the relationships among mathematics classroom environment, motivation, engagement, and performance as presented in Table 10. Classroom environment demonstrated a significant, large positive correlation with motivation (r = .694, p < .001) and engagement (r = .675, p < .001), as well as a significant small-to-moderate positive correlation with performance (r = .277, p < .001). Motivation showed a significant large positive correlation with engagement (r = .767, p < .001) and a significant small-to-moderate positive correlation with performance (r = .347, p < .001). Engagement yielded a significant moderate-to-large positive correlation with performance (r = .491, p < .001). Skewness and kurtosis values for all variables fell within acceptable ranges, indicating that the data approximated normality and satisfied the assumptions for parametric correlation analysis.

Table 10 Correlation of Mathematics Classroom Environment, Motivation, Engagement, and Performance (N=342)

Variables	**1**	**2**	**3**	**4**
1. Classroom Environment	1			
2. Motivation	0.649***	1		
3. Engagement	0.675***	0.767***	1	
4. Performance	0.277***	0.347***	0.491***	1
Mean	3.14	3.14	3.27	79.46
SD	0.30	0.43	0.41	13.49
Skewness	-0.15	-0.40	-0.37	0.00
Kurtosis	0.45	0.52	0.40	-0.93

* p < .05, ** p < .01, *** p < .001.

The mathematics classroom environment at this private higher education institution creates the fundamental conditions for learning, influencing students' motivation and active engagement. Students who are motivated actively participate, which further sustains their interest. This implies that motivation and engagement are mutually reinforcing. Furthermore, engagement turns out to be the main way that learning is translated into performance; while motivation and a supportive environment prepare students to learn, consistent effort on mathematical tasks has the most direct effect on grades. This highlights the need for students to exercise agency in converting classroom conditions into tangible achievement, with prior preparation and study habits remaining significant contributing factors.

Recent studies supported the findings above. A predictive study of college students found that learning engagement was the strongest predictor of mathematics performance, followed by learning environment and self-efficacy (Sabanal et al., 2024). A study from Sicuan (2024) found a significant moderate positive correlation between students' perceptions of their educational setting and their attitudes towards mathematics, emphasizing the impact of a supportive learning environment on student engagement. Another study found that student-perceived teacher enthusiasm indirectly predicted students' mastery goal orientation via perceived support for social relatedness and autonomy, reinforcing the importance of teacher characteristics and instructional processes in promoting student motivation (Gumartifa et al., 2023). These empirical findings collectively affirm that the classroom environment cultivates motivation and engagement, with engagement serving as the critical mechanism linking contextual factors to mathematics performance.

Engagement as a Significant Mediator

The indirect effect of classroom environment on mathematics performance through engagement alone was significant, $\beta = 0.18, p <.001$. The path from engagement to performance was significant, $\beta = 0.58, p < .001$. The path from classroom environment to engagement was significant, $\beta = 0.31, p < .001$. In contrast, the indirect effect of classroom environment on performance through motivation alone was non-significant, $\beta = -0.55, p = .582$.

A positive classroom environment does not directly improve mathematics test scores; rather, its influence reaches performance only after first increasing student engagement. When students actively participate, persist through difficult problems, and think carefully about mathematical concepts, their performance tends to improve. The classroom environment matters only to the extent that it successfully produces this kind of active engagement. A classroom may be well-organized and supportive, but if students remain passive recipients of information rather than active learners, their academic outcomes will not improve. Engagement serves as the essential bridge connecting a favorable learning context to meaningful achievement. The non-significant indirect path through motivation alone further reveals that motivation, when unaccompanied by actual engagement, does not lead to better performance.

In contrast, some studies have found that classroom environment directly predicts mathematics performance, with particular factors such as teacher support, disciplinary climate, and cognitive activation all having significant effects on student outcomes (Imam et al., 2025; Ramazan et al., 2023). However, the classroom environment also had an indirect influence by encouraging higher levels of mathematical self-efficacy and more positive academic attitudes, which in turn drive achievement (Abu, 2023).

Motivation Requires Engagement to Affect Performance

The serial indirect effect of classroom environment on performance through both motivation and engagement was significant, $\beta = 0.22, p < .001$. The path from motivation to engagement was significant, $\beta = 0.57, p < .001$. The path from classroom environment to motivation was significant, $\beta = 0.65, p < .001$. However, the direct path from motivation to performance was nonsignificant, $\beta = -0.04, p = .581$.

Motivation by itself does not raise mathematics performance. A student may feel very motivated to earn good grades, receive praise from parents, or even develop a genuine love for math. Yet this internal drive produces no academic benefit unless it transforms into engagement. The results show that motivation only contributes to performance when it first leads to increased engagement. In other words, wanting to do well is not the same as actually doing the work. A motivated student who does not actively participate, ask questions, think deeply, or persist through challenging problems will see no improvement in test scores. The strong relationship between motivation and engagement suggests that motivated students generally become engaged students. However, when this critical step fails, motivation remains an inactive psychological state with no academic consequence. For educators, this finding means that offering rewards, giving praise, or trying to generate excitement about math is not enough. Teachers must also provide clear pathways and structured opportunities for students to convert their motivation into observable academic engagement.

Table 11 Indirect, Direct, and Total Effects from the Serial Mediation Model of Classroom Environment on Performance through Motivation and Engagement

Type	*B*	*SE*	95% *BC CI [LL, UL]*	β	*z*
Indirect					
Classroom Environment → Motivation → Performance	-1.22	2.21	[-5.60, 2.63]	-0.03	-0.55
Classroom Environment → Engagement → Performance	8.02	1.55	[3.27, 13.77]	0.18	5.19***
Classroom Environment → Motivation → Engagement → Performance	9.62	1.60	[5.56, 15.66]	0.22	6.01***
Path					
Classroom Environment → Motivation	0.92	0.06	[0.72, 1.08]	0.65	15.77***
Motivation → Performance	-1.33	2.41	[-5.53, 2.83]	-0.04	-0.55
Classroom Environment → Engagement	0.42	0.06	[0.16, 0.64]	0.31	7.23***
Engagement → Performance	19.20	2.58	[14.56, 24.25]	0.58	7.44***
Motivation → Engagement	0.55	0.04	[0.37, 0.73]	0.57	13.37***
Direct					
Classroom Environment → Performance	-4.06	2.96	[-10.53, 2.81]	-0.09	-1.37
Total					
Classroom Environment → Performance	12.37	2.33	[6.33, 17.65]	0.28	5.31***

Note. $N = 342$. *CI* = confidence interval. Unstandardized estimates and standard errors (*SE*) are reported in original units. β represents the standardized coefficient. Confidence intervals were computed using the bias-corrected bootstrap method. Indented paths under each type belong to that category.

This was contrasted by some studies that reported student motivation is a significant direct predictor of performance in math (Michaelides et al., 2019; Winberg & Palm, 2021). However, Chahal et al. (2026) demonstrated that classroom engagement significantly mediates the relationship between learning motivation and academic satisfaction, indicating that motivation alone is insufficient without the mediating role of active engagement in the classroom setting. A study revealed that academic motivation and basic psychological needs act as partial mediators in the relationship between trait emotional intelligence and student engagement, confirming that motivation must be channeled through engagement to yield academic outcomes (Chin et al., 2025).

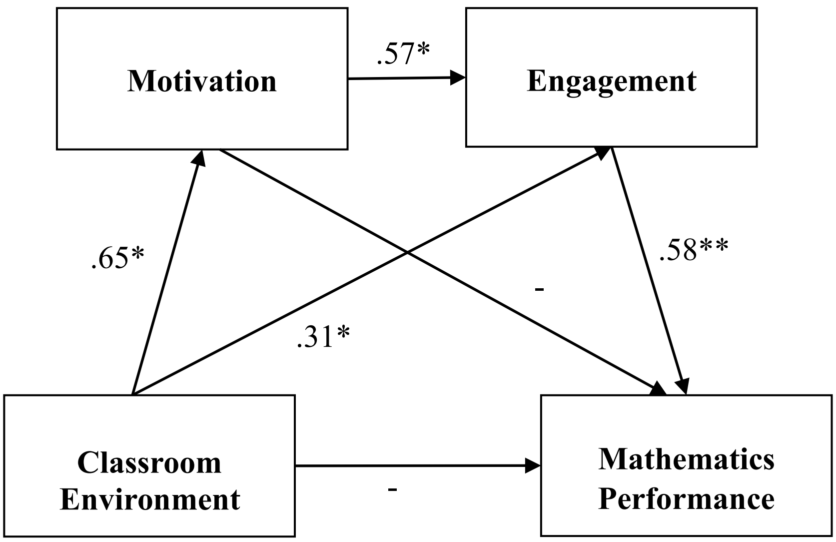

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Figure 2. Serial Mediation Model of Mathematics Classroom Environment, Motivation, Engagement, and Performance

A serial mediation analysis was conducted to examine the indirect effects of mathematics classroom environment on performance through motivation and engagement, as illustrated in Figure 2. The model estimated the direct and indirect pathways from classroom environment to motivation, motivation to engagement, and engagement to performance. Classroom environment demonstrated a significant positive direct effect on motivation ($\beta = 0.69, p < .001$). Motivation exhibited a significant positive direct effect on engagement ($\beta = 0.73, p < .001$). Engagement demonstrated a significant positive direct effect on performance ($\beta = 0.48, p < .001$). The indirect effect of classroom environment on performance through motivation and engagement was significant, with classroom environment influencing motivation, which in turn influenced engagement, and engagement ultimately influencing performance.

The serial mediation model reveals a clear chain of influence from the mathematics classroom to student achievement. The classroom environment works mainly through indirect pathways; it first shapes students' motivation, which then fuels their engagement, and it is this active participation that most directly affects their grades. This means that a supportive classroom and high motivation alone are not enough; students must consistently engage in the learning process, practicing problems, attending classes, and persisting through challenges, for these positive conditions to translate into better performance. For educators, this suggests a two-step approach: first, create a positive classroom climate to spark motivation, and second, provide structured opportunities that channel this motivation into meaningful academic behaviors, as the benefits of the learning environment are only realized when students actively do the work of learning.

FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

This chapter summarized the findings, draws conclusions, and formulates recommendations based on the objectives of this study.

Summary of Findings

The primary purpose of this study was to investigate the relationship among the mathematics classroom environment, student motivation, student engagement, and mathematics performance of college students in a private higher education institution. Specifically, it sought to determine the perceived levels of these variables and establish a best-fit model illustrating their influence on student achievement.

The findings revealed that college students in the private higher education institution perceived their mathematics classroom environment as high, indicating a generally positive and supportive learning context. Among the eight dimensions, teacher support and classroom discipline were perceived most favorably, while difficulty in learning and competition among students, though still within the high range, received relatively lower ratings, suggesting that students experience moderate academic challenges and competitive dynamics alongside a well-managed and supportive climate.

Regarding motivation, students reported a high overall level of drive to learn mathematics, with extrinsic motivation emerging as the strongest dimension, followed by perception of mathematics, whereas intrinsic motivation was the lowest but still rated high, implying that external rewards and recognition are primary drivers of their academic effort. In terms of engagement, students demonstrated a high level of active involvement in the Mathematics in the Modern World course, with behavioral engagement being the most pronounced, followed closely by cognitive engagement, while emotional engagement was comparatively lower, indicating that although students diligently participate and apply strategic thinking, they may find the subject less emotionally stimulating. However, the mathematics performance of the students was fairly satisfactory, reflecting that they generally meet baseline expectations but fall short of higher proficiency levels despite the favorable classroom environment, motivation, and engagement reported.

The mediation analyses revealed that the classroom environment does have a significant indirect effect on mathematics performance, through the sequential mediation of motivation followed by engagement. Specifically, the serial indirect pathway, from classroom environment to motivation, then to engagement, and finally to performance, was significant. This indicates that a supportive mathematics classroom environment first enhances students' motivation, which in turn increases their engagement, and it is this active engagement that ultimately leads to improved mathematics performance. Notably, the indirect effect of classroom environment on performance through motivation alone was not significant, nor was the direct effect of classroom environment on performance.

Likewise, motivation by itself, without being translated into engagement, did not directly predict performance. These findings confirm that motivation serves as an essential but insufficient condition; it must be converted into observable behavioral, emotional, and cognitive engagement to produce academic gains. The sequential chain of motivation and engagement fully mediates the influence of the classroom environment on mathematics performance.

Conclusion

Based on the findings of the study, the following conclusions are drawn:

Regarding the mathematics classroom environment, the findings indicate a generally positive and encouraging climate at this private higher education institution. High levels of teacher support, structured classroom management, and opportunities for student autonomy suggest a conducive and favorable atmosphere for learning mathematics. However, this supportive environment alone is not sufficient to ensure improved academic outcomes.

With respect to motivation in mathematics, the data show that college students are highly motivated in mathematics; nevertheless, this motivation is predominantly extrinsic. This indicates that students are primarily motivated by external incentives rather than intrinsic interest or personal enjoyment of the subject, thereby limiting the depth and sustainability of their learning.

In terms of engagement in mathematics, the data clearly demonstrate that college students exhibit a high level of engagement, particularly in behavioral and cognitive areas. This suggests that students are actively engaged in learning tasks and attempting to comprehend mathematical topics. Nonetheless, the relatively low emotional engagement suggests that students are not fully engaged in or connected to the lesson on a deeper level.

In terms of mathematical performance, the data conclude that college students' mathematics performance is only fairly satisfactory despite high levels of perceived classroom environment, motivation, and engagement. This discrepancy can be explained by the instructional and structural context of the institution. Instruction remains largely lecture-based with infrequent group work, limiting opportunities for deep cognitive processing. Consequently, high behavioral and cognitive engagement, while evident in attendance, participation, and effort, does not automatically translate into outstanding achievement when students lack prerequisite knowledge and when instructional methods emphasize passive learning over active problem solving.

In terms of the mediation analysis, the results conclude that the classroom environment has a significant indirect effect on mathematics performance, but only through the sequential mediation of motivation followed by engagement. The direct effect of classroom environment on performance is not significant, nor is the indirect effect through motivation alone. Moreover, motivation by itself does not directly predict performance. These findings confirm that a supportive classroom environment first enhances student motivation; that motivation must then translate into active behavioral, emotional, and cognitive engagement; and only then does engagement lead to improved mathematics performance.

Recommendations

Based on the findings and conclusions of this study, the following recommendations were proposed.

School administrators, particularly the Vice President for Academic Affairs, may mandate faculty development workshops on active learning strategies. The mediation model demonstrates that a supportive classroom environment alone does not improve mathematics performance; it must sequentially activate motivation and then engagement. Current lecture-based instruction and lack of remediation prevent this chain from raising student achievement beyond the fairly satisfactory level.

Program coordinators may revise the Mathematics in the Modern World course syllabus to include structured cooperative learning activities and observable participation requirements because the study confirms that motivation without subsequent engagement produces no academic benefit, and emotional engagement must be deliberately strengthened to complete the sequential pathway from classroom environment to performance.

Mathematics instructors may incorporate at least one brief active learning strategy and one emotionally engaging element, like real-world application or positive feedback, into every lesson because the findings demonstrate that engagement fully mediates the effect of motivation on performance; without such deliberate instructional design, even highly motivated students remain passive, and their effort fails to translate into higher test scores.

College students may actively participate in class discussions, ask questions, and form weekly study groups because the core finding of the study is that motivation only improves mathematics performance when it is converted into observable behavioral and cognitive engagement; wanting to do well is not enough unless accompanied by sustained academic effort and strategic thinking.

The researcher may pilot a classroom intervention that explicitly sequences supportive climate, motivational activities, and structured engagement tasks because the mediation model shows that the path to better performance is not a set of independent effects but a mandatory chain; testing this model in action may provide practical evidence for fellow instructors.

Future research can include variables such as prior knowledge, self-efficacy, and cognitive skills, as the regression model explained only a small percentage of the variance in performance, suggesting that other significant factors were missing.

Future research may conduct qualitative or longitudinal studies to explore why students report high engagement yet achieve only fairly satisfactory scores. The present design can only assert associations, and understanding the quality rather than mere quantity of engagement is essential for bridging the gap between positive perceptions and modest performance.

REFRENCES

1. Abalde, G. D., & Oco, R. M. (2023). Factors Associated with Mathematics Performance. Asian Research Journal of Mathematics, 19(6), 45–60. https://doi.org/10.9734/arjom/2023/v19i6665
2. Abu, F. N. (2023). Correlations Between Achievements in Mathematics, Student Characteristics, Classroom Climate, and Self-Efficacy. Journal of Higher Education Theory and Practice, 23(8).
3. Ahmed, G., Tayyub, M., & Ismail, R. (2020). Effects of Classroom Environment for Improving Students' Learning at Secondary Level in Punjab Province, Pakistan. Sci Academique, 1(1), 2–15. https://scienceacademique.com/effects-of-classroom-environment-for-improving-students-learning-at-secondary-level-in-punjab-province-pakistan/
4. Ahmed, N., & Pierre, D. P. (2024). The Role of Classroom Management in Enhancing Learners' Academic Performance: Teachers' Experiences. Studies in Learning and Teaching, 5(1), 202–218. https://doi.org/10.46627/silet.v5i1.364
5. Alrashidi, O., Phan, H. P., & Ngu, B. H. (2016). Academic Engagement: An Overview of Its Definitions,

Dimensions, and Major Conceptualisations. International Education Studies, 9(12), 41. https://doi.org/10.5539/ies.v9n12p41

6. Antao, M. A., Morales, R. S., Ting, V. B., Abdurahman, J. T., & Jalaidi, S. M. (2024). Behavior shift through non-traditional math teaching strategies, integrating real-life transactions for non-math enthusiasts. Environment and Social Psychology, 9(7), 1–16. https://doi.org/10.59429/esp.v9i7.2642
7. Aquino, R. M., Calantas, E. J., & Buen, M. T. (2024). Understanding Stem Learners: Engagement and Success in Mathematics. Antorcha, 10(1).
8. Arifin, Suryaningsih, & Arifudin, O. (2024). The Relationship Between Classroom Environment, Teacher Professional Development, And Student Academic Performance In Secondary Education. International Education Trend Issues, 2(2), 58–65.
9. Asare, B., Welcome, N. B., & Arthur, Y. D. (2024a). Influence of Parental Involvement and Academic Motivation on Mathematical Achievement: The Role of Students ’ Mathematics Interest. Jurnal Pendidikan Matematika, 1(2019), 295–312.
10. Asare, B., Welcome, N. B., & Arthur, Y. D. (2024b). Investigating the impact of classroom management, teacher quality, and mathematics interest on mathematics achievement. Journal of Pedagogical Sociology and Psychology, 6(2), 30–46. https://doi.org/10.33902/jpsp.202426232
11. Ayre, C., & Scally, A. J. (2015). Critical Values for Lawshe’s Content Validity Ratio : Revisiting the Original Methods of Calculation. December 2013. https://doi.org/10.1177/0748175613513808
12. Baiti, N. H., Devri, A. N., & Arga, K. I. (2024). The Impact of Learning Difficulties on Academic Achievement of Students: Analysis of Causal Factors and Solutions. International Journal of Educational Development, 1(3), 19–26. https://doi.org/10.61132/ijed.v1i2.46
13. Balayo, C. L. P., & Plaza, R. C. O. (2025). Check for Updates Intrinsic Motivation in the Post-Pandemic Education. Journal of Education and Human Development, 2978, 14–22.
14. Bandhu, D., Mohan, M. M., Nittala, N. A. P., Jadhav, P., Bhadauria, A., & Saxena, K. K. (2024). Theories of motivation: A comprehensive analysis of human behavior drivers. Acta Psychologica, 244(January), 104177. https://doi.org/10.1016/j.actpsy.2024.104177
15. Bangalan, R. C., & Hipona, J. B. (2020). Mathematics in the Modern World as a Science of Patterns with an Integration of Outcome-Based Teaching-Learning Approaches. Cosmos Journal of Engineering &Technology, 10(2), 17–25.
16. Barlow, A., Brown, S., Lutz, B., Pitterson, N., Hunsu, N., & Adesope, O. (2020). Development of the student course cognitive engagement instrument (SCCEI) for college engineering courses. International Journal of STEM Education, 7(1). https://doi.org/10.1186/s40594-020-00220-9
17. Bercades, R. K. D., & Cajandig, A. J. S. (2025). Culturally Driven Game-Based Strategies: A Tool for Developing Students’ 4C’s in Mathematics Education. International Journal of Research and Innovation in Applied Science, X(V). https://doi.org/10.51584/IJRIAS
18. Brandisauskiene, A., Buksnyte-Marmiene, L., Cesnaviciene, J., & Jarasiunaite-Fedosejeva, G. (2023). The Relationship Between Teachers’ Autonomy-Supportive Behavior and Learning Strategies Applied by Students: The Role of Teacher Support and Equity. SAGE Open, 13(2), 1–16. https://doi.org/10.1177/21582440231181384
19. Bureau, J. S., Howard, J. L., Chong, J. X. Y., & Guay, F. (2022). Pathways to Student Motivation: A Meta-Analysis of Antecedents of Autonomous and Controlled Motivations. Review of Educational Research, 92(1), 46–72. https://doi.org/10.3102/00346543211042426
20. Carandang, E. S. P., Caguete, R. R., & Balmes, J. M. R. (2024). Attitude and Challenges in Learning Mathematics in the Modern World (MMW): Basis for Intervention Program. International Journal of Material and Mathematical Sciences, 6(3), 85–99. https://doi.org/10.34104/ijmms.024.085099
21. Carbonel, L. G., Bayongan, A., Carino, M., Daguasi, I., Guzman, L., & Viloria, P. (2022). PAQIA: The Relationship between Freshman College Students’ Academic Performance and the Performance Analysis Quadrants, Interest, and Attitudes in Mathematics 11. International Journal of English Literature and Social Sciences, 7(6), 312–318. https://doi.org/10.22161/ijels.76.44
22. Chahal, A., Kadian, R., Yadav, R., & Prakash, C. (2026). Self-efficacy, learning motivation, and academic satisfaction of university students: mediating role of classroom engagement. Journal of Applied Research in Higher Education, 18(1), 238–253. https://doi.org/https://doi.org/10.1108/JARHE-06-2024-

0305
23. Chin, W. M., Ahmad, N. A., Ismail, I. A., Alias, S. N., & Asri, A. S. (2025). A Serial Mediation Model on Trait Emotional Intelligence, Basic Psychological Needs, and Academic Motivation as Antecedents of Student Engagement. SAGE Open, September, 1–19. https://doi.org/10.1177/21582440251352752
24. Commission on Higher Education. (2013). General Education Curriculum: Holistic Understandings, Intellectual and Civic Competencies. In Commission on Higher Education (pp. 1–29). https://ched.gov.ph/wp-content/uploads/2017/10/CMO-No.20-s2013.pdf
25. Dalimunthe, H. A., Dewi, I. K., Yunita, Y., Faadhil, F., & Lubis, D. M. G. S. (2024). Building a Supportive Learning Environment: The Role of Psychology in Increasing Student Motivation and Engagement. OPSearch: American Journal of Open Research, 3(4), 934–939. https://doi.org/10.58811/opsearch.v3i4.107
26. Dangi, M. R. M., Shuhidan, S. M., & Noor, R. M. (2025). Students' Perceptions on Extrinsic Motivation Strategies to Enhance Learning Experience and Fostering Academic Excellence: A Qualitative Study. International Journal of Research and Innovation in Social Science (IJRISS), IX(III). https://doi.org/10.47772/IJRISS
27. Daud, A. S., Adnan, N. S. M., Aziz, M. K. N. A., & Embong, Z. (2020). Students ' Perception towards Mathematics using APOS Theory : A Case Study Students ' Perception towards Mathematics using APOS Theory : A Case Study. Journal of Physics: Conference Series. https://doi.org/10.1088/1742-6596/1529/3/032020
28. Davidovitch, N., & Dorot, R. (2023). The Effect of Motivation for Learning Among High School Students and Undergraduate Students—A Comparative Study. International Education Studies, 16(2), 117. https://doi.org/10.5539/ies.v16n2p117
29. Demo, H., Garzetti, M., Santi, G., & Tarini, G. (2021). Learning mathematics in an inclusive and open environment: An interdisciplinary approach. Education Sciences, 11(5). https://doi.org/10.3390/educsci11050199
30. Edu, N. B. J., Minguez, X. J. B., Dabalos, S. C. D., & Taja-on, E. P. (2025). Untangling the "Why" of Math: Examining Student Perceptions on the Value of Mathematics in the Modern World. Journal of Tertiary Education and Learning, 3(1), 36–43. https://doi.org/10.54536/jtel.v3i1.3399
31. Elastika, R. W., Sukono, & Dewanto, S. P. (2021). Analysis of factors affecting students' mathematics learning difficulties using sem as information for teaching improvement. International Journal of Instruction, 14(4), 281–300. https://doi.org/10.29333/iji.2021.14417a
32. Eltahir, M. E., & Alsalhi, N. R. (2025). Impact of the flipped classroom on academic achievement, motivation, and engagement: A higher education case study. Contemporary Educational Technology, 17(1), 1–18. https://doi.org/10.30935/cedtech/15742
33. Eltayeb, R., Younis, A., Elamin, M., & Al Mostafa, F. A. (2025). Mathematics And its Applications. International Journal of Mathematics And Its Applications, 13(1), 37–45.
34. Endocal, K. H. R., & Baraquia, L. G. (2025). Determinants of Achievement Level in Mathematics in the Modern World among College Students. American Journal of Multidisciplinary Research and Innovation, 4(6), 58–71. https://doi.org/10.54536/ajmri.v4i6.6166
35. Feng, M., Wijaya, T. T., Ananda, R., & Du, W. (2025). Exploring factors influencing student satisfaction in mathematics education using PLS-SEM and fuzzy sets FsQCA. Scientific Reports, 15(1), 1–15. https://doi.org/10.1038/s41598-025-14459-1
36. Fiorella, L., Yoon, S. Y., Atit, K., Power, J. R., Panther, G., Sorby, S., Uttal, D. H., & Veurink, N. (2021). Validation of the Mathematics Motivation Questionnaire (MMQ) for secondary school students. International Journal of STEM Education, 8(1). https://doi.org/10.1186/s40594-021-00307-x
37. Fraser, B. J. (1998). Classroom Environment Instruments: Development, Validity and Applications. Learning Environments Research, 1, 7–34. https://doi.org/https://doi.org/10.1023/A:1009932514731
38. Gagaramusu, Y. B. M., Hariana, K., Purnamasari, D. I., & Wilade, S. (2026). Building Student Discipline Through Classroom Management Strategies : A Qualitative Study in Indonesian Elementary Schools. Journal of Innovation and Research in Primary Education, 5(1), 1761–1775.
39. Gumartifa, A., Syahri, I., Siroj, R. A., Nurrahmi, M., & Yusof, N. (2023). Perception of Teachers Regarding Problem-Based Learning and Traditional Method in the Classroom Learning Innovation

Process. Indonesian Journal on Learning and Advanced Education (IJOLAE), 5(2), 151–166. https://doi.org/10.23917/ijolae.v5i2.20714

40. Gutierrez Jr., A. C., & Doronio, R. G. (2024). Classroom Social Environment and Student Engagement in Mathematics: A Correlational Study. European Journal of Education Studies, 11(8), 297–317. https://doi.org/10.46827/ejes.v11i8.5471
41. Gyamfi, A. (2022). Application of Classical Test Theory (CTT) in the Validation of Teacher Made Mathematics Multiple Choice Test (MMCT) Items. Asian Journal of Advanced Research and Reports, 16(11), 1–12. https://doi.org/10.9734/AJARR/2022/v16i11434
42. Han, K. (2021). Fostering Students' Autonomy and Engagement in EFL Classroom Through Proximal Classroom Factors: Autonomy-Supportive Behaviors and Student-Teacher Relationships. Frontiers in Psychology, 12(October), 1–7. https://doi.org/10.3389/fpsyg.2021.767079
43. Harold, K., Endocal, R., & Baraquia, L. G. (2025). Determinants of Achievement Level in Mathematics in the Modern World Among College Students. International Journal for Multidisciplinary Research (IJFMR), 7(5), 1–21.
44. Hayes, A. F. (2013). Introduction to Mediation, Moderation, and Conditional Process Analysis. Guilford Publications, Inc.
45. Hidayatullah, A., Abidin, R., & Muqit, A. (2024). Motivation and Behavioral Engagement: the Mediating Role of Mathematics Self-Efficacy in Primary Education. Journal on Efficiency and Responsibility in Education and Science, 17(3), 237–246. https://doi.org/10.7160/eriesj.2024.170306
46. Hossein-Mohand, H., & Hossein-Mohand, H. (2023). Influence of motivation on the perception of mathematics by secondary school students. Frontiers in Psychology, 13(January), 1–16. https://doi.org/10.3389/fpsyg.2022.1111600
47. Howard, J. L., Slemp, G. R., & Wang, X. (2024). Need Support and Need Thwarting: A Meta-Analysis of Autonomy, Competence, and Relatedness Supportive and Thwarting Behaviors in Student Populations. Personality and Social Psychology Bulletin. https://doi.org/10.1177/01461672231225364
48. Hu, Z., Lin, L., Wang, Y., & Li, J. (2021). The Integration of Classical Testing Theory and Item Response Theory. Psychology, 12, 1397–1409. https://doi.org/10.4236/psych.2021.129088
49. Imam, I., Ayyubi, A., Nurfajriyah, D. S., & Prayetno, E. (2025). Does the Learning Environment Affect Students ' Mathematics Achievement ? Wulang: Jurnal Ilmiah Pendidikan Guru Madrasah Ibtidaiyah, 03(2), 19–29.
50. Irinco, J. P. L. (2025). Students' Attitudes and Academic Achievement in Mathematics in the Modern World (MMW): A Correlational Analysis. Asian Journal of Advanced Research and Reports, 19(6), 86–93. https://doi.org/10.9734/ajarr/2025/v19i61044
51. Isıkgoz, M. E. (2025). Intrinsic vs . extrinsic motivation in high school physical education : Which fuels adolescent achievement emotions better ? PLoS ONE, 1–22. https://doi.org/10.1371/journal.pone.0327393
52. Ispas, C., & Ispas, A.-M. (2023). Challenges and Solutions of Discipline in Contemporary Classroom Education. Educatia 21, 26, 4–17. https://doi.org/10.24193/ed21.2023.26.01
53. Jaafar, W. N. W., & Maat, S. M. (2020). the Relationship Between Self-Efficacy and Motivation With Stem Education: a Systematic Literature Review. International Journal of Modern Education, 2(4), 19–29. https://doi.org/10.35631/ijmoe.24002
54. Joshi, D. R., Adhikari, K. P., Khanal, B., Khadka, J., & Belbase, S. (2022). Behavioral, cognitive, emotional and social engagement in mathematics learning during COVID-19 pandemic. PLoS ONE, 17(11 November), 1–22. https://doi.org/10.1371/journal.pone.0278052
55. Kalu, F., & Salahuddin, Z. (2022). Academic Program Development Guide. University of Calgary in Qatar.
56. Kennedy, I. (2022). Sample Size Determination in Test-Retest and Cronbach Alpha Reliability Estimates. British Journal of Contemporary Education, 2(1), 17–29. https://doi.org/10.52589/bjce-fy266hk9
57. Kim, S. B., & Lee, J. (2021). Regression - Based Mediation Analysis : a Formula for the Bias due to an Unobserved Precursor Variable. Journal of the Korean Statistical Society, 50(4), 1058–1076. https://doi.org/10.1007/s42952-021-00105-9
58. Knopik, T., & Oszwa, U. (2023). Self-Determination in Maths Education: How to Strengthen Students'

Positive Attitude to Mathematics and Develop Their Emotional/Social Competences. In Multidisciplinary Journal of School Education (Vol. 12, Issue 1 (23)). https://doi.org/10.35765/mjse.2023.1223.08
59. Linao, D. J. R. (2025). Innovation Strategies in Teaching Mathematics: A Quasi- Experimental Approach. International Journal of Research and Innovation in Social Science (IJRISS), VII(2454), 1175–1189. https://doi.org/10.47772/IJRISS
60. Liu, J., Sun, Y., & Li, Y. (2026). The impact of the mathematical adversity quotient on preparatory students ' mathematics learning engagement : moderated mediation effect analysis. Frontiers in Psychology, March. https://doi.org/10.3389/fpsyg.2026.1725090
61. Maamin, M., Maat, S. M., & Iksan, Z. H. (2022). The Influence of Student Engagement on Mathematical Achievement among Secondary School Students. Mathematics, 10(14). https://doi.org/https://doi.org/10.3390/ math10010041
62. Makaremi, N., Yildirim, S., Morgan, G. T., Touchie, M. F., Jakubiec, J. A., & Robinson, J. B. (2024). Impact of classroom environment on student wellbeing in higher education: Review and future directions. Building and Environment, 265(August), 111958. https://doi.org/10.1016/j.buildenv.2024.111958
63. Manjunatha, N. (2021). Quantitative Methods: Descriptive Research. Journal of Emerging Technologies and Innovative Research, 6(6), 863–867.
64. Mazana, M. Y., Montero, C. S., & Casmir, R. O. (2020). Assessing Students' Performance in Mathematics in Tanzania: The Teacher's Perspective. International Electronic Journal of Mathematics Education, 15(3), em0589. https://doi.org/10.29333/iejme/7994
65. Mcguire, M., & Mcguire, M. (2025). Impact of Competition-Based Learning on Student Engagement and Performance. International Journal of Construction Education and Research, 00(00), 1–30. https://doi.org/10.1080/15578771.2025.2512348
66. Michaelides, M., Brown, G. T. L., Eklöf, H., & Papanastasiou, E. (2019). The Relationship of Motivation with Achievement in Mathematics. International Association for the Evaluation of Educational Achievement, 9–23. https://doi.org/10.1007/978-3-030-26183-2
67. Middleton, F. (2019). Reliability vs. Validity in Research | Difference, Types and Examples. Scribbr. https://www.scribbr.com/methodology/reliability-vs-validity/
68. Mirzaei, M., Shavoun, A. H., & Tehran, H. A. (2025). Enhancing student motivation in higher education: Evidence-based strategies for effective teaching. Med Edu Bull, 6(17), 1005–1014. https://doi.org/10.22034/MEB.2025.523614.1108
69. Momoh, O. (2025). Population: Definition in Statistics and How to Measure It. Investopedia.
70. Moroscallo, T. (2024). Mathematics Anxiety's Impact on Grade 11 General Mathematics Performance. Journal of Interdisciplinary Perspectives, 2(7), 283–288. https://doi.org/10.69569/jip.2024.0100a
71. Mutia, I. C. (2025). Exploring Students ' Challenges in Understanding Mathematical Concepts. Psychology and Education: A Multidisciplinary Journal, 10, 1418–1439. https://doi.org/10.70838/pemj.421006
72. Nguyen, T. N. T., & Oanh, D. T. K. (2025). Cooperative learning and its influences on student engagement. Cogent Education, 12(1). https://doi.org/10.1080/2331186X.2025.2513414
73. Nikolopoulou, K. (2023). What Is Content Validity? | Definition & Examples. Scribbr.
74. Nindiasari, H., & Samad, M. A. (2024). Effect of Classroom Learning Environment on the Academic Performance of Students at the Secondary Level. The Third International Conference on Government Education Management and Tourism (ICoGEMT)+HEALTH, 1–8.
75. Ntumi, S., Agbenyo, S., & Bulala, T. (2023). Estimating the Psychometric Properties (Item Difficulty) of Test Items using Kuder-Richardson Approach (KR-20). Shanlax International Journal of Education, 11(3), 18–28. https://doi.org/https://doi.org/10.34293/ education.v11i3.6081
76. Obeng, P., Srem-Sai, M., Salifu, S. I., Amoadu, M., Arthur, F., Agormedah, K., Hagan, J. E. J., & Thomas, S. (2025). Linking students ' grit and academic engagement : Mediating role of academic motivation and self- - regulated learning. British Educational Research Journal, July 2024, 2511–2535. https://doi.org/10.1002/berj.4185
77. OECD. (2023). PISA 2022 Results (Volume I): The State of Learning and Equity in Education: Vol. I. OECD Publishing. https://doi.org/https://doi.org/10.1787/53f23881-en

78. Onen, D., & Ayiorwoth, H. (2025). Barriers to Adopting Innovative Teaching Methods in Private Secondary Schools in Gulu City: Implications for Curriculum Implementation. Journal of Curriculum Development, Evaluation, and Education (JCDEE), 1(2), 1–20. https://doi.org/10.64948/jcdee.v1.i2.2025.92
79. Padawag, M. D. (2025). Student Perception on The Factors Influencing Their Math Performance in Bokod, Benguet, Philippines. Journal of Education, Learning, and Management, 2(2), 242–262. https://doi.org/10.69739/jelm.v2i2.900
80. Panerio, A. M. S., & Delideli, J. A. (2025). Geometric Proof Struggles on Academic Achievements in Mathematics among Third Year College Students. International Journal For Multidisciplinary Research, 7(2), 1–8. https://doi.org/10.36948/ijfmr.2025.v07i02.38443
81. Papageorgiou, E., Wong, J., Liu, Q., Khalil, M., & Cabo, A. J. (2025). A Systematic Review on Student Engagement in Undergraduate Mathematics: Conceptualization, Measurement, and Learning Outcomes. In Educational Psychology Review (Vol. 37, Issue 3). Springer US. https://doi.org/10.1007/s10648-025-10046-y
82. Pondias, J. V., & Tado, P. P. (2025). The Mediating Role of Attitude Towards Mathematics in the Relationship Between Classroom Management and Mathematics Engagement Among Students. EPRA International Journal of Multidisciplinary Research (IJMR)-Peer Reviewed Journal, 11(3), 198–210. https://doi.org/10.36713/epra20585
83. Pornel, J. B. (2013). Four Common Misuses of the Likert Scale. ResearchGate, January 2013.
84. Prabhakar, T., & Kaushal, K. (2024). Prospective Versus Cross - Sectional Study Design – Wordplay of Timing of Study Conduct and Measurement. Indian Journal of Dermatology, 4103. https://doi.org/10.4103/ijd.ijd
85. Putri, L., Rezani, M. R., & Hermina, D. (2025). Correlational Research Design. Jurnal Riset Multidisiplin Edukasi, 2, 306–317.
86. Qin, Z., Yang, G., Lin, Z., & Ning, Y. (2025). The impact of academic burnout on academic achievement : a moderated chain mediation effect from the perspective. Frontiers in Education.
87. Rajeh, J., Bassam, F., & In, M. (2023). Impact of classroom environment, teacher competency, information and communication technology resources, and university facilities on student engagement and academic performance. International Journal of Information Management Data Insights, 3(2), 100188. https://doi.org/10.1016/j.jjimei.2023.100188
88. Ramazan, O., Danielson, R. W., Rougee, A., Ardasheva, Y., & Austin, B. W. (2023). Effects of classroom and school climate on language minority students ' PISA mathematics self-concept and achievement scores. Large-Scale Assessments in Education. https://doi.org/10.1186/s40536-023-00156-w
89. Reeve, J., Jang, H., Carrell, D., Jeon, S., & Barch, J. (2022). Enhancing students' engagement by supporting their autonomy, competence, and relatedness. Motivation and Emotion, 46(2), 203–216.
90. Ridhuan, M., Dangi, M., Shuhidan, S. M., & Noor, R. M. (2025). Students ' Perceptions on Extrinsic Motivation Strategies to Enhance Learning Experience and Fostering Academic Excellence : A Qualitative Study. International Journal of Research and Innovation in Social Sciences (IJRISS), IX(2454), 3985–3999. https://doi.org/10.47772/IJRISS
91. Rivera-Gómez-Barris, B., & El Homrani Maknuzi, M. (2025). Clarifying and fostering student autonomy in high-risk educational settings: insights from secondary teachers in Spain and Chile. Frontiers in Education, 10(December), 1–23. https://doi.org/10.3389/feduc.2025.1660370
92. Rodenas, S. D. (2025). Perceived Leadership Style, Job Satisfaction, and Affective Commitment among Employees in Higher Education Institution. International Journal of Research and Innovation in Social Sciences, IX(2454). https://doi.org/10.47772/IJRISS
93. Rodenas, S. D., & Menes, C. (2026). Total Quality Management Practices in Multi-Awarded Cooperatives in Northern Negros : A Mixed Method Study. International Journal for Research and Innovation in Social Sciences, X(2454). https://doi.org/10.47772/IJRISS
94. Rodrigo, D. B., & Prudente, P. R. (2024). Academic Achievement of College Students in Mathematics in the Modern World in the Changing Normal. International Journal of Social Science, Management and Economics Research, 2(2), 1–14. https://ijssmer.com/pub/ijssmer/article/view/27
95. Roebianto, A., Savitri, S. I., Aulia, I., Suciyana, A., & Mubarokah, L. (2023). Content Validity:

Definition and Procedure of Content Validation in Psychological Research. TPM - Testing, Psychometrics, Methodology in Applied Psychology, 30(1), 5–18. https://doi.org/10.4473/TPM30.1.1

96. Rone, N. A., Amor, N., Guao, A., Jariol, M. S., Acedillo, N. B., Balinton, K. R., & Francisco, J. O. (2023). Students' Lack of Interest, Motivation in Learning, and Classroom Participation: How to Motivate Them? Psych Educ, 7(March), 585. https://doi.org/10.5281/zenodo.7749977
97. Ryan, R. M., & Deci, E. L. (2020). Intrinsic and extrinsic motivation from a self-determination theory perspective: Definitions, theory, practices, and future directions. Contemporary Educational Psychology, 61. https://doi.org/10.1016/j.cedpsych.2020.101860
98. Ryan, R. M., Jang, H., Wang, J. C. K., Matos, L., Gordeeva, T., Kaplan, H., Behzadnia, B., Kantas, Ö., Ferber, K. A., Soenens, B., & Vansteenkiste, M. (2025). Variations in Need Supports in Education as a Function of Cultural and Economic Factors : Perspectives from Self- Determination Theory. Eduactional Psychology Review, 1–36.
99. Sabanal, D., Gako, M., Torre, H. Dela, So, R. B., Bacal, J. B., Corgio, L. D., Laroga, J. F., Camallere, C., Pagador, M. J., Barino, R. J., Mameng, K., Go, M., & Goles, N. (2024). Social Sciences & Humanities Open Predictive model for college students ' performance in higher mathematics. Social Sciences & Humanities Open, 10(July), 101134. https://doi.org/10.1016/j.ssaho.2024.101134
100. Salifu, A. S., & Bakari, A. (2022). Exploring the Relationship Between Students ' Perception , Interest and Mathematics Achievement. Mediterranean Journal of Social & Behavioral Research, 6(1), 13–20.
101. Salvacion, R. (2025). Teachers' Innovative Strategies and Engagement: Their Influence to Learners' Performance. International Journal of Science and Management Studies (IJSMS), October, 217–233. https://doi.org/10.51386/25815946/ijsms-v8i5p113
102. Sen, E. O. (2022). Middle School Students' Engagement in Mathematics and Learning Approaches: Structural Equation Modelling. Pedagogical Research, 7(2), em0124. https://doi.org/10.29333/pr/11908
103. Shao, Y., Feng, Y., Zhao, X., Liu, G., & Zhang, L. (2025). Teacher support and secondary school students' learning engagement: A moderated mediation model. Scientific Reports, 15(1), 1–12. https://doi.org/10.1038/s41598-025-87366-0
104. Shuaili, A. S. T. (2025). Educational Research and Reviews Intrinsic and extrinsic motivation as predictors of academic achievement and learning attitudes: Evidence from Omani schools. AJ Educational Research and Reviews, 20(6), 86–100. https://doi.org/10.5897/ERR2025.4474
105. Sicuan, S. R. (2024). Attitudes and Educational Settings : A Correlational Analysis. Journal of Interdisciplinary Perspectives, 2(7), 759–766.
106. Soe, H. Y., Zhang, D., Fu, D., & Cui, Y. (2025). How an autonomy-supportive learning environment influences students' achievements in science and mathematics. Social Psychology of Education.
107. Solomon, O. I. (2020). Factors Influencing Students 'Academic Performance in Mathematics in Ukwuani L.G.A, Delta State, Nigeria. Educational Quest- An International Journal of Education and Applied Social Sciences, 7(3), 291.
108. Su, C. (2024). Learning Environment as an Influencer of Students' Performance in A University in China. Journal of Education and Educational Research, 9(2), 283–287. https://doi.org/10.54097/53wwyp21
109. Sujatha, S., & Vinayakan, K. (2023). Engaging Students With Mathematics : A Review Of Motivation and Engagement Strategies. 8(2), 55–60.
110. Tay, L. Y., Lee, S. S., & Ramachandran, K. (2021). Implementation of Online Home-Based Learning and Students' Engagement During the COVID-19 Pandemic: A Case Study of Singapore Mathematics Teachers. Asia-Pacific Education Researcher, 30(3), 299–310. https://doi.org/10.1007/s40299-021-00572-y
111. Thomas, L. (2023). Stratified Sampling | Definition, Guide & Examples. Scribbr.
112. Torrejos, R. L. (2024). College Students' Engagement in Mathematics in the Modern World: The Influential Role of Perceived Teaching Performance of Instructors and Critical Thinking Skills in a Blended Learning Environment. European Journal of Contemporary Education and E-Learning, 2(3), 74–89. https://doi.org/10.59324/ejceel.2024.2(3).07
113. Ulmanen, S., Rautanen, P., Soini, T., Pietarinen, J., & Pyhältö, K. (2023). How do teacher support trajectories influence primary and lower-secondary school students' study well-being. Frontiers in Psychology, 14(August), 1–12. https://doi.org/10.3389/fpsyg.2023.1142469

114. Wang, C. K. J., Reeve, J., Liu, W. C., Kee, Y. H., Ng, B., Chua, L. L., & Kong, L. C. (2025). An autonomy-supportive intervention program for STEM teachers to enhance engagement among students. Heliyon, 11(3), e42150. https://doi.org/10.1016/j.heliyon.2025.e42150
115. Wang, Y., Wang, H., Wang, S., Wind, S. A., & Gill, C. (2024). A systematic review and meta-analysis of self-determination-theory-based interventions in the education context. Learning and Motivation, 87(June), 102015. https://doi.org/10.1016/j.lmot.2024.102015
116. Wang, Y., Zuo, M., He, X., & Wang, Z. (2025). Exploring Students' Online Learning Behavioral Engagement in University: Factors, Academic Performance, and Their Relationship. Behavioral Sciences, 15(1), 1–24. https://doi.org/10.3390/bs15010078
117. Wilkins, J. L. M., Jones, B. D., & Rakes, L. (2021). Students' Class Perceptions and Ratings of Instruction: Variability Across Undergraduate Mathematics Courses. Frontiers in Psychology, 12(June), 1–17. https://doi.org/10.3389/fpsyg.2021.576282
118. Winberg, M., & Palm, T. (2021). Antecedents and Relative Importance of Student Motivation for Science and Mathematics Achievement in TIMSS. Frontiers in Education, 6(March). https://doi.org/10.3389/feduc.2021.575926
119. Wongvorachan, T. (2023). The Impact of Classroom Competition and Cooperation to Student Academic Performance. Sustainability (Switzerland), 11(1), 1–14. https://doi.org/10.31234/osf.io/7vugd
120. Yakar, Z. Y. (2023). The Effect of the Online Flipped Learning Model in Higher Education: Examination of Students' Engagement, Views and Experiences. Asian Journal of Distance Education, 18(2), 75–93. https://www.asianjde.com/ojs/index.php/AsianJDE/article/view/748
121. Yang, Y., Chen, J., & Zhuang, X. (2025). Self-determination theory and the influence of social support, self-regulated learning, and flow experience on student learning engagement in self-directed e-learning. Frontiers in Psychology, 16. https://doi.org/10.3389/fpsyg.2025.1545980
122. Yang, Y., Li, G., Su, Z., & Yuan, Y. (2021). Teacher's Emotional Support and Math Performance: The Chain Mediating Effect of Academic Self-Efficacy and Math Behavioral Engagement. Frontiers in Psychology, 12(September), 1–10. https://doi.org/10.3389/fpsyg.2021.651608
123. Zhang, M. (2025). Teacher Support and Students' Achievement in Mathematics—Discovery and Enlightenment Based on PISA 2022 East Asian Cultural Circle Data. Journal of Education, Humanities and Social Sciences, 52, 11–23. https://doi.org/10.54097/ebnmae77
124. Zimmerman, I., Tal, T., & Baram-Tsabari, A. (2025). Cognitive, affective, and behavioral engagement with science news predicted by the use of accessibility strategies in science-minded and general audiences. Public Understanding of Science, 34(1), 92–113. https://doi.org/10.1177/09636625241252561