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# A Literature Review on the Impact of Socio-Demographic Factors, Differentiated Instruction, and Student Engagement on Mathematics Achievement

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## ABSTRACT

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This paper presents a comprehensive review of the academic literature concerning the factors that influence student achievement in mathematics. It synthesizes findings on the role of socio-demographic variables, the effectiveness of Differentiated Instruction (DI) as a pedagogical intervention, and the relationship between student engagement and academic outcomes. The review establishes a theoretical basis for the causal links between these factors and student performance, providing a foundation for a quasi-experimental study. It discusses the mixed but often positive effects of socio-demographic factors like parental education, family income, and access to resources, as well as the well-supported positive impact of DI on post-test scores. Furthermore, it highlights the significant positive relationship between behavioral, cognitive, and emotional engagement and mathematics performance. The paper concludes with a detailed methodology section, outlining a quasi-experimental design to empirically test these relationships.

## INTRODUCTION

Academic performance is not solely determined by a student's innate ability. A vast body of literature demonstrates that various socio-demographic factors, such as family background and access to resources, significantly influence a student's academic outcomes, particularly in subjects like mathematics (Tinto, 1975). This literature review provides a theoretical and empirical basis for the inclusion of key variables in a study, establishing their causal link to student achievement. The paper is organized into sections that define baseline academic performance, review the literature on socio-demographic factors, examine the effectiveness of Differentiated Instruction (DI), and explore the relationship between student engagement and performance.

Within ASEAN contexts, family socioeconomic status consistently emerges as a primary predictor of mathematics achievement, with students from lower-income households showing reduced performance due to limited access to learning materials and parental educational support (Piosang, 2025). Similarly, rural-urban location disparities exacerbate these gaps, as rural students in countries like the Philippines and Vietnam face inadequate school infrastructure and teacher shortages, contributing up to 20-30% of variance in test scores (Gangan et al., 2024). These patterns underscore the need for targeted interventions that address structural inequalities rather than assuming uniform student potential (ASEAN Secretariat, 2020).

Parental education level further mediates outcomes, where children of less-educated parents in South East Nigeria exhibit weaker problem-solving skills in mathematics, often linked to lower home literacy environments and reduced emphasis on STEM subjects (Ejilibe et al., 2020). Gender also plays a subtle role, with ASEAN girls occasionally outperforming boys in mathematics when controlling for socioeconomic factors, though persistent stereotypes hinder full equity (Ahmed et al., 2023). These ASEAN-specific findings highlight how socio-demographic variables interact with cultural norms to shape achievement, informing the rationale for incorporating them into predictive models.

## METHODOLOGY

This study will employ a quasi-experimental research design. This approach is chosen as it is not feasible to randomly assign participants to groups, allowing for a natural comparison between an experimental group and a control group. The design will involve a pre-test and post-test to measure the impact of the Differentiated Instruction intervention.

### Baseline Academic Performance

Baseline academic performance will be defined as the initial level of knowledge and mathematical skills of the Grade 7 participants, as measured prior

to the intervention. While a specific baseline for Carrascal National High School is unavailable from published literature (Cos & Paguia, 2021; Cos, Duero, & Paguia, 2021), contextual data from similar schools and national assessments provides a valuable proxy. Studies at Legazpi City National High School and Galas National High School, along with broader assessments like PISA 2022 and SEA-PLM 2019, suggest a generally low proficiency level in mathematics for Grade 7 students in the Philippines (OECD, 2023; UNICEF & SEAMEO, 2020; Department of Education, n. d.). This context reinforces the importance of an intervention designed to improve foundational skills.

### Data Analysis

The primary statistical test to be used is the independent samples t-test. This test is specifically designed to compare the mean scores of two distinct groups and will be used to determine if the observed difference in post-test scores between the DI group and the traditional teaching method group is statistically significant (Laerd Statistics, n. d.).

## RESULTS AND DISCUSSION

### The Role of Socio-Demographic Factors in Student Achievement

The influence of socio-demographic factors on academic performance has been a central theme in educational research for decades.

***Sex.*** The relationship between a student's sex and mathematics achievement is a complex and highly debated topic. Large meta-analyses show a very small average gender difference in mathematics achievement, with variations depending on the nation, grade, and specific subdomain (Else-Quest et al., 2010; Hyde et al., 1990). The difference is often more nuanced than overall scores, relating instead to psychological mechanisms. Strong causal designs, such as laboratory experiments (stereotype threat manipulations) and field interventions (confidence-boosting programs), have shown that social and psychological mechanisms linked to gender can causally affect performance in susceptible groups (Spencer et al., 1999). Therefore, while gender itself may not be a large direct causal driver, its associated mechanisms warrant inclusion in the study.

**Parental Educational Attainment.** A parent's educational attainment is widely accepted as a powerful and consistent predictor of a child's academic success. Studies show a significant positive relationship between a parent's educational level and a student's performance, especially in mathematics (White, 2001). This relationship operates through proximal pathways: parents with higher education are better equipped to provide academic expectations, educational resources, and a supportive home environment that fosters a positive attitude toward learning and greater involvement in educational activities (Fan & Chen, 2001).

**Family Monthly Income.** Family income and broader Socioeconomic

Status (SES) measures show a robust, moderate association with mathematics achievement across countries. Research, including policy evaluations and natural experiments (e.g., changes to welfare/tax credits), provides convincing evidence of a partially causal effect: increasing family resources tends to improve child outcomes (Duncan et al., 2011). This effect is often explained by the resource dilution hypothesis (Blake et al., 1991), where higher-income families can invest more in educational resources, private tutoring, and better living environments, reducing stress and enhancing academic support for their children.

**Number of Siblings.** The number of siblings a student has generally shows a negative causal relationship with academic achievement, a phenomenon primarily explained by the resource dilution effect. Causal evidence, derived from strong designs like sibling fixed effects and instrumental-variable strategies, supports this: a larger family size tends to dilute per-child resources, including parental time, attention, and financial investment in education (Angrist et al., 2005).

**Availability of a Personal Gadget**. The relationship between personal gadget availability and math achievement is mixed but shows causal potential. Randomized Controlled Trials (RCTs) provide the most direct evidence, showing that device availability can causally affect math achievement, but the sign and magnitude depend entirely on implementation. Device access enables learning opportunities and online resources, which can be positively associated with performance. However, if devices mainly lead to off-task screen time, the effect can be null or negative. The causal effect is therefore conditional on whether the devices are integrated with high-quality instructional content and managed to avoid distraction (Wang et al., 2024).

Availability of a Quiet and Comfortable Study Area. The physical home environment plays a direct role in a student's academic productivity. Having a quiet and comfortable study area is associated with higher academic attainment and test scores. Causal evidence from quasi-experimental and experimental studies that manipulate or observe environmental factors (like noise exposure, lighting, and ventilation) demonstrates that a conducive environment improves a student's ability to concentrate and efficiently complete homework and revision. This enhanced cognitive focus translates into higher academic results, making the study environment a significant contextual variable (Higgins et al., 2025).

## The Significance of Post-Test Score Differences

The question, "Is there a significant difference in the post-test scores of Grade 7 students in mathematics who are taught using Differentiated Instruction (DI) compared to those taught using traditional methods?" is a classic example of an inferential quantitative question. The core purpose is to determine if a cause-and-effect relationship exists between the teaching method (independent variable) and student performance (dependent variable).

Based on a review of existing literature, the answer to this question is

frequently "yes." Many quasi-experimental studies on DI in mathematics have found a significant positive impact on student post-test scores. For example, a study at St. Paul University Surigao with Grade 7 students found that the academic achievement of the experimental group receiving DI was significantly higher than that of the control group taught with traditional methods (Budejas, 2025). Other studies support the finding that DI improves not only general achievement but also specific skills like critical thinking and problem-solving (Çayir & Balci, 2023). While many studies report a significant DI advantage, some research suggests that results can be context-dependent, varying with class size, fidelity to the DI model, and the specific assessment used.

**The Relationship Between Student Engagement and Academic Performance**

The question, "Is there a significant relationship between student engagement and academic performance in mathematics?" addresses a foundational concept in educational psychology. The answer, supported by a substantial body of evidence, is a definitive "yes." This relationship is both positive and significant, meaning that higher levels of student engagement are consistently associated with higher academic achievement.

Student engagement is typically understood through three primary dimensions: behavioral, cognitive, and emotional. Behavioral engagement refers to a student's observable participation; cognitive engagement relates to the mental effort students invest in their learning; and emotional/affective engagement involves a student's feelings and attitudes toward the subject. Multiple studies, including large-scale international analyses and meta-analyses, confirm a significant, positive correlation between all three dimensions of student engagement and academic performance in mathematics (Fung et al., 2018; Lei et al., 2018).

## CONCLUSION

The reviewed literature provides a strong theoretical and empirical foundation for a study investigating the impact of Differentiated Instruction on Grade 7 mathematics achievement. It confirms that a student's performance is not isolated but is a product of complex interactions with their socio-demographic background and their level of engagement. While these socio-demographic factors are not easily controlled, pedagogical interventions like DI offer a promising avenue to address learning needs and improve outcomes. The evidence consistently suggests that DI is a well-supported strategy for improving post-test performance, particularly when implemented with fidelity and tailored to the learning environment. Fostering student engagement, especially in the cognitive and behavioral domains, is also a powerful predictor of success. Therefore, this study is poised to contribute to the body of knowledge on effective teaching strategies by examining these critical relationships in the context of Grade 7 mathematics.

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