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Differentiated Instruction in Mathematics Achievement: Validating McKenzie’s Domain of Multiple Intelligences

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ABSTRACT

This study was conducted to determine the effect of using McKenzie’s domain of multiple intelligences as a way of validating differentiated instruction in response to mathematics achievement. This study used the nonequivalent control group design. The instruments used in this study is a 90-item adopted Multiple Intelligence test and a 30-item teacher-made test for the topics on The Embodiment of Circles and Introduction to Coordinate Geometry. The difference between the pre-test and post-test of the experimental and control groups is generally not significant. Although the study failed to reject the null hypothesis stating that there is no significant difference of the mean gain scores of the experimental and control groups, the increase of the mean gain scores of the experimental and control group implies that there is a positive development in the math achievement of the students if differentiated instruction is applied when students are grouped according to McKenzie’s domain of intelligences. Appropriate assessment must be employed when applying differentiated instruction to identify the student’s dominant domains of intelligences. Moreover, although the traditional technique had a positive impact in the mathematical achievement of students, varied use of techniques may also be implied to address their needs. The differentiated instruction by McKenzie may significantly impact students’ academic performance; therefore, it should be encouraged.

INTRODUCTION

In an era increasingly defined by technology and quantitative reasoning, mathematical competence is a critical determinant of student success. However, persistent challenges in mathematics education, particularly in the Philippines, reveal a significant gap between curricular goals and student achievement. International and local assessments consistently indicate that Filipino students struggle with higher-order mathematical concepts and problem-solving, often due to abstract presentation and uniform instructional methods that fail to address learner diversity (Nebres & Lee-Chua as cited by Arespachoga, 2011). This context underscores an urgent need for pedagogical innovations that cater to varied student readiness, interests, and cognitive profiles. Differentiated Instruction (DI) is a promising philosophy that advocates tailored teaching to maximize individual learning potential (Tomlinson, 2005). Grounded in the Theory of Multiple Intelligences (Gardner, 1983), DI acknowledges that students possess diverse intellectual strengths. This study investigates the integration of DI, specifically validated through McKenzie’s (2002) domains of multiple intelligences, as a strategy to enhance mathematics achievement. The primary objective is to determine the effect of this approach on Grade 10 students’ performance in specific geometry and coordinate geometry topics, compared to traditional lecture-based methods. By doing so, this research contributes to the evolving discourse on responsive pedagogy and offers evidence-based insights

for curriculum design and teacher practice in diverse mathematics classrooms.

LITERATURE REVIEW

A strong foundation for utilizing Differentiated Instruction (DI) to address academic diversity is established within the literature. Differentiated Instruction is defined as a teaching philosophy that adapts content, process, and product based on students’ varying readiness levels, interests, and learning profiles (Tomlinson, 2005). It moves beyond a “one-size-fits-all” model, aiming to create an inclusive classroom where all students can access rigorous curriculum and experience success (Lawrence-Brown, 2004; Subban, 2006). Empirical research indicates that DI can lead to improved student outcomes, increased motivation, and a more positive classroom environment (McAdamis, 2001). However, significant implementation barriers exist, including teacher resistance, perceived time constraints, and concerns over classroom management (Tomlinson, 2005; Robinson, 2004), which are compounded by broader issues of teacher burnout and challenging school climates (Gallego, 2024). A key theoretical underpinning for DI is Howard Gardner’s Theory of Multiple Intelligences, which posits that intelligence is not a single entity but comprises distinct modalities such as linguistic, logical-mathematical, spatial, and interpersonal intelligences (Gardner, 1983). This theory challenges traditional, uniform teaching and assessment practices. McKenzie (2002) organized these intelligences into three practical domains for educators:

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Analytic (logical, musical, naturalist), Interactive (linguistic, interpersonal, kinesthetic), and Introspective (existential, intrapersonal, visual). This framework aids teachers in planning instruction that engages varied cognitive pathways, a planning necessity underscored by initiatives like Catch-Up Fridays which require tailored instructional strategies (Raymunde *et al.*, 2024). The convergence of DI and multiple intelligences theory is particularly relevant for mathematics education, where abstract concepts often pose difficulties (Altun, 2000). Studies suggest that students frequently perform poorly on word problems despite adequate computational skills, highlighting a disconnect in problem-solving application (Hegarty *et al.*, 1992), a challenge that may be addressed by fostering greater metacognitive awareness in learners (Montillado, 2023). DI, when informed by multiple intelligences, can make mathematics more accessible and meaningful by connecting content to students' diverse strengths and lived experiences (Gregory & Chapman, 2013). For instance, cooperative learning activities can engage interpersonal intelligence, while visual tools can support spatial learners. Prior research, such as that by McAdamis (2001), shows positive gains in mathematics scores following DI implementation. However, further investigation is needed to specifically examine the efficacy of DI structured explicitly around McKenzie's (2002) domains in improving mathematics achievement, which this study seeks to address.

MATERIALS AND METHODS

This study employed a quasi-experimental, non-equivalent control group design (Campbell & Stanley, 1966). Participants were 90 Grade 10 students from Stella Maris Academy of Davao during the 2015-2016 academic year, selected via purposive sampling. They were divided into an experimental group (n=45) and a control group (n=45), with each group comprising students classified under McKenzie's three intelligence domains: Analytic, Interactive, and Introspective. The independent variable was the teaching strategy. The experimental group received instruction on circle geometry and coordinate geometry topics through DI,

with activities tailored to their dominant intelligence domain (e.g., worksheet drills for Analytic, cooperative learning for Interactive, reflective tasks for Introspective). The control group was taught the same content using traditional lecture and activity methods. The dependent variable was academic achievement, measured by a validated, reliable 30-item teacher-made test (KR-20 = 0.8103).

Data collection involved administering a Multiple Intelligence Test for grouping, followed by a pre-test for both groups. After a six-week intervention, a post-test was administered. Data analysis utilized mean and standard deviation to describe achievement levels. Independent samples t-tests were conducted at a 0.05 significance level to compare the pre-test scores, post-test scores, and mean gain scores between the control and experimental groups, addressing the research hypotheses.

RESULTS AND DISCUSSION

This study employed a quasi-experimental design to investigate the effect of Differentiated Instruction (DI), validated through McKenzie's (2002) domains of multiple intelligences, on the mathematics achievement of Grade 10 students in the Philippines. The analysis compares the performance of an experimental group (taught with DI) and a control group (taught traditionally) across the Analytical, Interactive, and Introspective domains.

Table 1 presents the pre-test and post-test mean scores for both groups. The pre-test scores across all domains and groups were uniformly classified as "Poor," indicating equivalent, low baseline knowledge of the geometry topics prior to intervention (Arespacochaga, 2011; Takele, 2009). Post-intervention, both groups showed marked improvement. Notably, the experimental group's Analytical domain achieved an "Outstanding" rating (Mean Percent = 81.16), surpassing the control group's "Very Satisfactory" rating (74.33%). While both groups achieved "Very Satisfactory" in the Interactive and Introspective domains, the experimental group's scores were consistently higher, suggesting a positive trend associated with DI (Hodge, 1997; McAdamis, 2001).

Table 1: Pre-test and Post-test Mean Scores by Domain and Group

Domain	Group	Pre-test Mean (%)	Description	Post-test Mean (%)	Description
Analytical	Experimental	32.75	Poor	81.16	Outstanding
	Control	30.64	Poor	74.33	Very Satisfactory
Interactive	Experimental	27.95	Poor	77.69	Very Satisfactory
	Control	28.10	Poor	70.24	Very Satisfactory
Introspective	Experimental	35.19	Poor	70.00	Very Satisfactory
	Control	37.00	Poor	72.67	Very Satisfactory

Note: Description based on Sucano (2012) qualitative scale.

Statistical analysis of score differences is shown in Table 2. As expected, no significant differences existed in pre-test scores between groups (all $p > .05$), confirming group equivalence at the baseline. The key finding emerges in the post-test analysis: a statistically significant difference was found for the Analytical domain ($p = .030$), leading to

the rejection of the null hypothesis for this domain. This indicates that DI specifically enhanced performance for students with analytical strengths. However, no significant post-test differences were found for the Interactive ($p = .065$) or Introspective ($p = .609$) domains.

Table 2: T-test Results for Pre-test and Post-test Score Differences

Domain	Pre-test t-value	Pre-test p-value	Post-test t-value	Post-test p-value
Analytical	0.603	0.550	2.243	0.030*
Interactive	0.033	0.974	1.932	0.065
Introspective	0.353	0.728	0.521	0.609
*Significant at $\alpha = 0.05$ *				

The significant gain in the Analytical domain aligns with the theoretical promise of DI to leverage student strengths (Tomlinson, 2005). Activities designed for analytical learners (e.g., worksheet drills, logical problem-solving) directly matched the cognitive processes required by the post-test, which was itself an analytical instrument. This finding underscores the critical principle of alignment between instructional methods, learner profiles, and assessment tools (Gregory & Chapman, 2013). The lack of significant differences in the Interactive and Introspective domains may thus reflect an assessment mismatch; the post-test did not adequately measure the kinesthetic, interpersonal, or intrapersonal skills cultivated through DI activities for those domains (Lawrence-Brown, 2004). This highlights a common implementation challenge: while instruction can be

differentiated, standardized assessments often remain analytically biased, potentially masking the full impact of DI (Tomlinson, Moon, & Callahan, 1998).

Table 3 shows the mean gain scores. Although the experimental group showed higher gains in the Analytical and Interactive domains, these differences were not statistically significant (all $p > .05$). This suggests that while DI, particularly for analytical learners, can lead to superior post-intervention outcomes, the magnitude of improvement from baseline was not statistically distinct from that achieved through traditional methods over the study period. This nuanced result corroborates findings that both structured traditional teaching and DI can yield gains, but DI may better optimize peak performance for specific learner profiles (Valiandes, 2015).

Table 3: Mean Gain Scores and Difference

Domain	Experimental Mean Gain	Control Mean Gain	t-value	p-value
Analytical	14.52	13.14	1.318	0.195
Interactive	14.92	12.64	1.615	0.119
Introspective	10.44	10.70	-0.136	0.894

This study contributes to the literature by empirically validating the application of McKenzie’s domain-specific DI in a Philippine secondary school context. The primary finding, that DI significantly benefits analytically-inclined students in mathematics, reinforces the need for diagnostic assessment of student intelligences. However, the study also reveals a pivotal challenge: the dominance of analytical assessment. For DI to be fully validated and its benefits for all domains realized, assessment practices must diversify to authentically measure interactive and introspective competencies (Gardner, 1983). Future research should employ multi-modal assessments to capture the comprehensive effects of DI. Furthermore, sustained professional development is essential to help teachers design and implement domain-aligned instruction and evaluation, moving beyond a one-size-fits-all pedagogy to truly responsive mathematics education (Tomlinson, 2005).

CONCLUSIONS

This study concludes that Differentiated Instruction, when structured and validated through McKenzie’s domains of multiple intelligences, is an effective pedagogical strategy for enhancing mathematics achievement, particularly for

students with analytical learning strengths. The significant improvement observed in the analytical domain of the experimental group underscores the importance of aligning instructional methods with students’ cognitive profiles and, crucially, with the mode of assessment. A key limitation of this research lies in the analytical bias of the assessment instrument, which likely obscured the full impact of the intervention on students with interactive or introspective intelligences, revealing a common challenge in equitable educational evaluation. The findings affirm the relevance of learner-centered approaches in diverse mathematics classrooms and highlight the necessity of developing diversified, domain-sensitive assessment tools to measure and foster different forms of mathematical understanding accurately. For effective application, curriculum designers and teacher training programs should integrate domain-specific differentiation strategies while advocating for balanced assessment frameworks. It is recommended that future implementations couple differentiated instruction with multi-modal evaluations to fully capture and nurture the broad spectrum of student intelligences, thereby moving toward a more inclusive and responsive mathematics education.

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