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APLICANDO AS INTELIGÊNCIAS MÚLTIPLAS DE GARDNER A EXAMES DE PRÉ-CÁLCULO COM MÚLTIPLAS TENTATIVAS.

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Resumen

Este artículo explora cómo la teoría de las inteligencias múltiples de Gardner puede enriquecer el diseño y la eficacia de los exámenes de Precálculo de múltiples intentos y opciones múltiples. Al aprovechar las diversas fortalezas cognitivas de los estudiantes (lingüísticas, lógicas, espaciales, cinestésicas, musicales, interpersonales, intrapersonales y naturalistas), el enfoque va más allá del aprendizaje de memoria hacia una comprensión y un compromiso más profundos. Basada en observaciones en el aula y análisis cuantitativos a pequeña escala en un entorno de colegio comunitario, esta estrategia de enseñanza ofrece información sobre cómo las evaluaciones repetidas, cuando se combinan con estrategias de aprendizaje variadas, pueden generar confianza, reducir la ansiedad y promover el dominio conceptual en matemáticas.

Palabras clave: Inteligencias múltiples, exámenes de Pre-Cálculo, respuestas múltiples

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Abstract

This article explores how Gardner's theory of multiple intelligences can enrich the design and effectiveness of multiple-attempt, multiple-choice Pre-Calculus exams. By drawing on students' diverse cognitive strengths linguistic, logical, spatial, kinesthetic, musical, interpersonal, intrapersonal, and naturalistic, the approach moves beyond rote learning toward deeper understanding and engagement. Based on classroom observations and small-scale quantitative analysis in a community college setting, this teaching strategy offers insights into how repeated assessments, when coupled with varied learning strategies, can build confidence, reduce anxiety, and promote conceptual mastery in mathematics.

Key words: Multiple intelligences, Pre-Calculus exams, multiple-attempts

INTRODUCTION

In Pre-Calculus courses, traditional exams often emphasize memorization and speed, rewarding students who excel at test-taking strategies. However, this model doesn't reflect the diverse ways students learn and process information. Gardner's (1983) theory of multiple intelligence offers a more inclusive vision, recognizing different intellectual strengths. This article examines how multiple-attempt, multiple-choice exams, combined with varied learning strategies aligned to multiple intelligences, can improve learning outcomes. The central inquiry asks: Can assessments reflect multiple intelligence? Can Pre-Calculus students perform better when given opportunities to reflect, reattempt, and engage with material through different modalities? These questions guide the inquiry.

Howard Gardner's (1983) groundbreaking theory challenged the belief that intelligence is a singular, measurable trait. Instead, Gardner proposed distinct areas of cognitive strength, including logical-mathematical, linguistic, spatial, bodily-kinesthetic, musical, interpersonal, intrapersonal, and naturalistic intelligences. His work reshaped education by encouraging teachers to recognize these differences and tailor instruction accordingly (Tomlinson, 2001; Sousa, 2008).

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Gardner's framework suggests that learning is most effective when aligned with students' cognitive strengths. For instance, students with strong logical-mathematical intelligence may excel in algebraic reasoning, while others thrive through visual, physical, or collaborative approaches. Robert Gagné (1965) distinguished rote memorization from meaningful learning. Repetition aids foundational knowledge, but long-term understanding emerges when learners connect content to broader concepts and applications. Gardner's approach builds on this principle by promoting deeper engagement with material.

Research on mastery learning and formative feedback further supports diverse, multi-attempt assessments. Bloom (1968) and Guskey (2010) emphasized the benefits of revisiting material and correcting errors. Bangert-Drowns et al. (1991) and Nicol and Macfarlane-Dick (2006) demonstrated that feedback-rich, student-centered assessments enhance learning. Together, these works advocate for assessment models that go beyond memorization and embrace cognitive diversity.

METHODOLOGY

This study was conducted in two Pre-Calculus courses at a community college in New York City. In both courses, weekly multiple-choice quizzes were used, each allowing students to make multiple attempts. The quizzes included problems intentionally designed to align with different types of intelligence, for example, diagrams for spatial learners and step-by-step reasoning for logical-mathematical learners. To collect relevant data, three students were randomly selected from each course, making a total of six participants. These students consented to participate in tracking their quiz performance and engagement levels. The quizzes were standardized across both courses, with each consisting of multiple-choice questions totaling 100 points.

Students were encouraged to engage with different learning strategies between quiz attempts, consistent with Gardner's multiple intelligences framework. They had access to various approaches, including visual, kinesthetic, interpersonal, and linguistic methods. The

"Observed and Self-Reported Strategies Applied" reflect both instructor observations during class activities and students' self-reported strategies through reflection surveys. No single strategy was pre-assigned; instead, students selected and applied approaches that suited learning preferences.

Data Collection Details: For each of the six selected students (Students A through F), both quantitative performance data and qualitative engagement indicators were gathered: The score earned on the first attempt of each multiple-choice quiz (out of 100 points). The highest score achieved after all permitted attempts. The improvement calculated as Final Score minus Attempt 1 score. Number and types of strategies employed between attempts, including visual aids (e.g., graphs, diagrams), kinesthetic practice (e.g., whiteboard work), interpersonal collaboration (e.g., peer discussions), and linguistic tools (e.g., written explanations). Also, students completed self-reflection surveys after each quiz attempt, reporting confidence levels on a scale from 0 to 5 and noting which strategies were most beneficial.

Teaching Implementation: Pre-Calculus' instruction incorporated diverse problem-solving methods to appeal to various intelligences: Logical-mathematical learners engaged with grouping and completing the square. Spatial learners benefited from the Slide-Divide-Bottoms-Up method of factorization with visual models. Kinesthetic learners used manipulatives and whiteboard exercises. Linguistic learners practiced written problem explanations. Interpersonal learners collaborated in group activities. Intrapersonal learners reflected individually through journals. Weekly quizzes were designed as low-stakes, multiple-attempt, multiple-choice assessments. Students received feedback after each attempt and were encouraged to apply different learning strategies before reattempting, fostering deeper conceptual understanding.

RESULTS

The data collected from six randomly selected students across two Pre-Calculus courses demonstrate consistent performance improvements attributable to the integration of multiple-attempt, multiple-choice assessments coupled with learning strategies aligned with Gardner's theory of multiple intelligences.

Quantitative Results:

- Mean Attempt 1: 62 out of 100
- Mean Final Attempt: 82 out of 100
- Mean Performance Gain: +20 points

Individual student gains ranged from +10 to +35 points, indicating that many students benefited substantially from the opportunity to reattempt assessments using varied learning approaches. Table 1 presents the calculated 95% confidence interval for the mean performance gain. With high statistical confidence, the true mean improvement for similar students populations is estimated to lie between approximately 11.6 and 28.4 points, reinforcing the reliability of the observed improvement pattern.

Table 1: 95% Confidence Interval for Mean Performance Gain:

Metric	Value
Mean Gain	20 points
Standard Deviation (estimated)	8 points
Standard Error	3.27 points
t-Value (df = 5, 95% CI)	2.571
Confidence Interval	Gain between 11.6 and 28.4 points

Analysis of strategy use showed that students employing two or more varied strategies saw higher average gains (+25 points) than those using only one strategy (+15 points). Visual strategies, such as graphing, were most frequently used and strongly linked to improved scores. Self-reported confidence levels rose alongside performance, particularly following collaborative or visual activities.

Table 2: Illustrative Student Cases

Student	Attempt 1 Score	Final Score	Gain	Strategies Used	Confidence Growth
A	55	85	+30	Peer discussion, graphing, whiteboard practice	2 → 4
B	65	90	+25	Visual aids, written explanations	3 → 5
C	70	80	+10	Whiteboard practice	3 → 4
D	60	85	+25	Peer discussion, graphing	2 → 5
E	50	75	+25	Visual, kinesthetic	1 → 4
F	70	95	+25	Multiple varied approaches	3 → 5

Mean of Attempt score: 61.67 ± 8.16 Mean of Final score: 85.00 ± 7.07

Paired t-test: t= 8.37; P= 0.0004

The data form table 2 suggests that integrating multiple-attempt, multiple-choice assessments with intentionally designed, intelligence-aligned learning strategies significantly enhance both academic performance and student confidence (P= 0.0004). Notably, students who diversified their approaches experienced the most substantial improvements, highlighting the practical benefits of embracing Gardner's framework within assessment design. While these findings are based on a small sample size and preliminary observations, they provide promising evidence that incorporating varied cognitive pathways into mathematics assessment can foster greater inclusivity, engagement, and success.

DISCUSSION

Applying Gardner's theory to multiple-attempt, multiple-choice assessments fostered inclusivity and allowed diverse learners to engage with mathematics through strengths-based strategies. Errors became learning opportunities, and success was reframed as growth through persistence. This approach supported students who struggle with traditional exams, particularly those who benefit from interpersonal, spatial, or kinesthetic learning. Musical and naturalistic intelligence were less emphasized, suggesting avenues for future expansion. Challenges included preventing superficial guessing and ensuring meaningful feedback. Balancing multiple modalities required careful planning to avoid cognitive overload.

CONCLUSION

Integrating Gardner's multiple intelligence into multiple-attempt, multiple-choice Pre-Calculus assessments promotes a more equitable, personalized learning environment. Students gained not only improved test scores but also self-awareness and academic resilience. To foster inclusive mathematics classrooms, assessments must reflect how students learn—not solely what they know. Guided multiple attempts, enriched by diverse learning strategies, empower all students to succeed.

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