



PSYCHOLOGICAL DETERMINANTS OF STUDENT ACHIEVEMENT: A COMPREHENSIVE ANALYSIS BASED ON TIMSS FRAMEWORK

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Raupova Sojida Abduvaitovna

Lecturer at the Department of Mathematics and Mother Tongue in Primary Education, Termez State Pedagogical Institute.

***Abstract:** The Trends in International Mathematics and Science Study (TIMSS) serves as a global barometer for educational quality. However, raw test scores often mask the underlying psychological mechanisms that drive academic performance. This article explores the multidimensional psychological determinants—ranging from cognitive load and mathematical anxiety to self-efficacy and growth mindset—that influence student outcomes. By synthesizing data from multiple TIMSS cycles, this study argues that psychological resilience and emotional regulation are as critical as pedagogical content delivery in securing high-ranking educational achievement. According to data from various TIMSS cycles, student academic success is not solely dependent on textbooks or teacher expertise. Mathematical anxiety often acts as a cognitive barrier, causing even gifted students to underperform. In such cases, a student's working memory is consumed by managing fear rather than solving complex problems, leading to a significant drop in potential output.*

***Keywords:** TIMSS, Mathematical Anxiety, Self-Efficacy, Cognitive Load, Growth Mindset, Psychological Resilience.*

Introduction

The global educational landscape is increasingly competitive, with the TIMSS assessment providing a standardized lens through which to view national performance in Mathematics and Science [1, p.181]. While curriculum alignment and teacher quality are vital, they do not fully account for the variance in student performance. Recent advancements in educational psychology suggest that

"psychological determinants"—the internal cognitive and emotional states of a learner—act as the ultimate filter for knowledge acquisition and reproduction.

TIMSS items, particularly at the “Applying” and “Reasoning” levels, demand high cognitive processing. According to Sweller’s Cognitive Load theory, the human brain has a limited working memory capacity[2; p. 417-423]

- Intrinsic Load: Related to the complexity of the mathematical problem itself.
- Extraneous Load: Created by the way information is presented or by the student’s internal state (e.g., anxiety). High-performing students in TIMSS often exhibit superior executive functions, allowing them to manage this load more effectively[12, p.580].

Reinhard Pekrun’s Control-Value Theory explains that students feel "achievement emotions" (pride, boredom, shame) based on the value they place on a task and their perceived control over it. TIMSS success is highest when students value the subject (subjective value) and feel they have the tools to master it (subjective control)[16, p. 315-341]. Top-tier students in TIMSS assessments don't just solve problems; they monitor their own solution paths. This metacognitive awareness—knowing when to switch strategies or re-read a prompt—is a primary psychological determinant that separates high-achievers from average performers. The TIMSS "Students Like Learning Mathematics" and "Students Confident in Mathematics" scales are strong predictors of achievement. Albert Bandura’s Self-Efficacy Theory posits that a student’s belief in their ability to succeed determines how much effort they expend and how long they persist in the face of obstacles[3; p.604]. Students with high self-confidence in TIMSS consistently score significantly higher (often by over 50 scale points) than those with low self-confidence.

Mathematical anxiety is not merely a lack of confidence; it is a psychological condition that triggers a “fight or flight” response. Neuroimaging shows that in

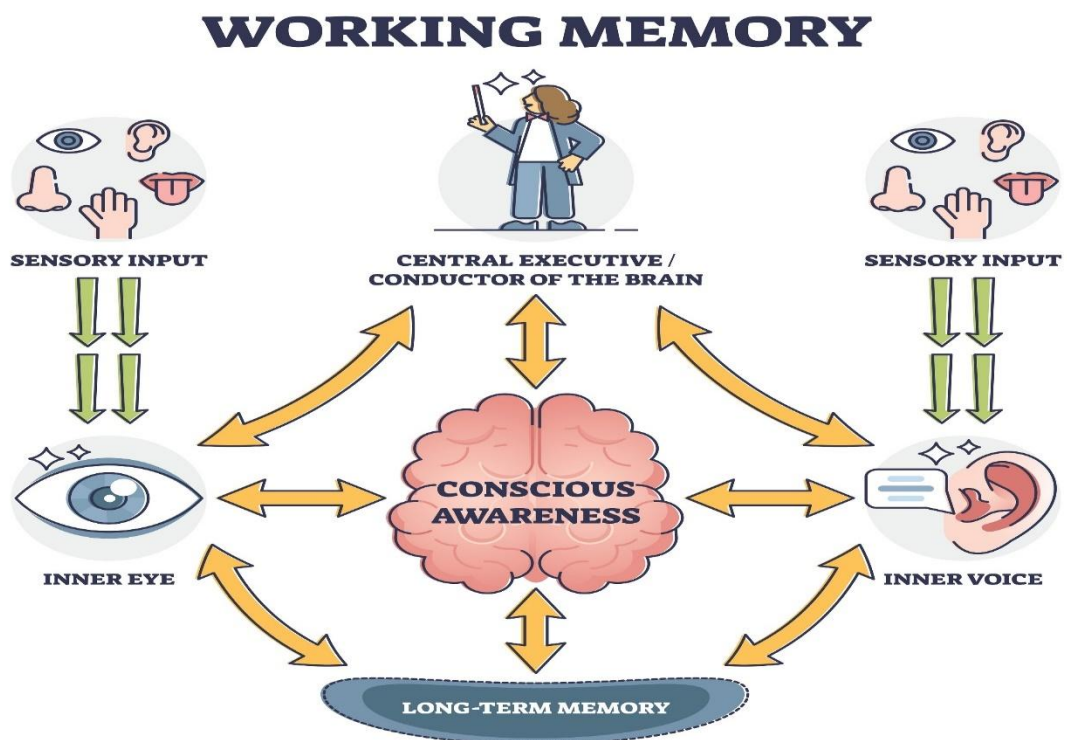
anxious students, the brain's amygdala is overactive, which interferes with the prefrontal cortex (responsible for logic). This “emotional hijacking” prevents students from accessing the knowledge they actually possess during the exam.

Carol Dweck’s research into mindsets is highly applicable to TIMSS. In countries like Singapore and Japan, there is a cultural emphasis on “effort-based intelligence”[7;p.277]. Students who believe their intelligence can grow are more likely to embrace the “Reasoning” challenges of TIMSS than those who believe intelligence is a static trait[14, p.667].

Psychological safety is a prerequisite for cognitive engagement. TIMSS data indicates that students who experience bullying or feel alienated from their school community show decreased performance. The psychological determinant here is belongingness, which reduces stress hormones and allows the brain to focus on higher-order learning[17,p.257].

High-achieving students have automated basic facts (e.g., multiplication tables), freeing up cognitive resources for the complex “Reasoning” domain of TIMSS.

(1-picture).



To improve TIMSS scores, educational systems must move beyond "drill and kill" methods and adopt

Psychological scaffolding:

1. Anxiety reduction: incorporating mindfulness and low-stakes testing.
2. Attribution retraining: teaching students to attribute failure to lack of effort/strategy rather than lack of ability.
3. Positive feedback loops: strengthening the student's academic self-concept through incremental successes.

Psychological safety is a prerequisite for cognitive engagement. TIMSS data indicates that students who experience bullying or feel alienated from their school community show decreased performance. The psychological determinant here is belongingness, which reduces stress hormones and allows the brain to focus on higher-order learning. A classroom that punishes mistakes stifles the intellectual risk-taking required for TIMSS. Psychological safety, a term coined by Amy Edmondson, allows students to ask questions and propose "wrong" answers as part of the learning process[8, p.340]. Believing math ability is an innate gift. These students avoid challenges to protect their ego, believing math ability is developed through effort. These students embrace TIMSS challenges as puzzles to be solved[19,p.68].

Metacognition is "thinking about thinking." It involves planning, monitoring, and evaluating one's own problem-solving process. High-achieving students monitor their own solution paths, recognizing when a strategy isn't working and adjusting accordingly[20, p.440]. This self-regulation is a primary differentiator between average and elite performers in international assessments. (2-picture).



Psychological safety is the belief that one will not be punished for making a mistake. In classrooms where mistakes are ridiculed, students' brains stay in “survival mode,” releasing cortisol which damages the hippocampus (the memory center). TIMSS data confirms that a supportive school climate is directly correlated with higher academic achievement[21,p.13].

To improve TIMSS scores in Uzbekistan, the following reforms are proposed:

1. Metacognitive questioning: moving away from "What is the answer?" to “How did you find that answer?”
2. Attribution retraining: helping students attribute failure to a lack of strategy rather than a lack of innate ability.

Conclusion

The psychological determinants of student achievement are the “hidden variables” in the TIMSS equation. A student may possess the requisite mathematical knowledge, but without the psychological infrastructure—confidence, emotional regulation, and a growth mindset—that knowledge remains inaccessible during high-stakes evaluations. Future educational reforms must integrate psychological well-being as a core pillar of academic excellence.

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