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**UNCOVERING MATHEMATICS CHALLENGES: A COMPARATIVE  
ANALYSIS OF FACTORS AFFECTING TRADE MATHEMATICS (TMA)  
STUDENTS AT THE NATIONAL UNIVERSITY OF SAMOA.**

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### **ABSTRACT**

This study examines the multidimensional factors contributing to mathematics learning challenges among Trade Mathematics (TMA) students at the National University of Samoa (NUS) through a mixed-methods analytical framework. Quantitative data were drawn from institutional assessment records for two cohorts (2023,  $n = 72$ ; 2024,  $n = 85$ ), including Week 7 assessments, Week 14 assessments, and Final Examination results. These were complemented by qualitative data obtained from structured questionnaires, Talanoa focus groups, and instructor interviews. The study investigated the effects of foundational knowledge, pedagogical approaches, academic support systems, and affective variables—particularly mathematics anxiety and self-efficacy—on student performance. Regression analyses revealed substantial differences in predictive stability between at-risk and not-at-risk student groups. For the 2023 cohort, early assessments demonstrated limited predictive value for at-risk learners, whereas mid-semester assessments emerged as stronger predictors in 2024 following targeted interventions. Qualitative findings indicated persistent foundational gaps, limited alignment between teaching methods and vocational learning needs, and high levels of mathematics anxiety. However, students reported increased engagement and confidence after the introduction of diagnostic testing and expanded tutoring services. The findings demonstrate that mid-semester diagnostics combined with structured academic support significantly improve outcomes for at-risk students. The study concludes that TVET institutions must institutionalise routine diagnostic assessment, culturally sustaining pedagogy, and embedded support systems to enhance mathematics achievement and workforce readiness in Pacific contexts.

**KEYWORDS:** Trade Mathematics, TVET, mathematics anxiety, diagnostic assessment, academic support, Samoa.

## **INTRODUCTION**

Mathematics functions as a foundational pillar for advancement in science, technology, engineering, and vocational sectors, profoundly influencing both personal and national development (Team, 1995; Siaw, Geok, & Azizan, 2020). In Samoa's technical and vocational education and training (TVET) landscape, proficiency in mathematics is essential for student success in programs like Trade Mathematics (TMA) at the National University of Samoa (NUS).

Despite its importance, many TMA students experience persistent difficulties with mathematics. Issues such as gaps in foundational knowledge, ineffective teaching practices, limited academic support, and math anxiety continue to disrupt achievement and engagement (Ashcraft, 2002). These learning obstacles not only hinder individual progress and employability but also present significant challenges for national workforce development.

Over the past decade, alarming patterns have emerged across Pacific and Samoan educational research—including declining math performance and student disengagement, high failure rates, and feedback from instructors regarding readiness and support needs. Several regional and international studies suggest that effective interventions can address these problems, but gaps remain in the local evidence base, especially regarding how student attitudes, teaching methods, curricular alignment, and support services interact to affect outcomes within Samoa's TVET context.

### **Historical and Policy Background:**

Samoa's TVET sector has undergone significant reform to align secondary and tertiary learning pathways, address resource constraints, and improve instructional quality. However, persistent mathematics challenges among TMA learners highlight the need for institutional systems that strengthen foundational skills, promote culturally relevant teaching, and prioritize coordinated support.

### **Roadmap:**

This paper first reviews the theoretical and empirical literature on TVET mathematics challenges (Section 2), then details the mixed-methods research design and sampling approach employed in this study (Section 3). Section 4 presents the analysis of student outcomes and the impact of recent interventions, while Section 5 discusses the implications

for policy and practice. The paper concludes (Section 6) with targeted recommendations and a call to action for educators and policymakers.

### **Problem Statement**

TMA students at the National University of Samoa consistently face profound challenges in mathematics, as evidenced by high failure rates, academic disengagement, and dissatisfaction with learning experiences. These challenges are rooted in multiple factors: limited foundational knowledge from primary and secondary schooling, teaching strategies poorly adapted to TVET learners, insufficient academic support infrastructures, and widespread math anxiety.

Despite mathematics' essential role in vocational and technical fields, there is a noticeable gap in targeted research addressing the specific barriers encountered by TMA students at NUS. This gap impedes the design and implementation of effective interventions, leaving students underprepared for both academic and career demands.

### **Motivation**

This research is motivated by the critical necessity of elevating the academic success and professional readiness of TMA students. Given mathematics' pivotal influence on technical skill development, addressing learners' difficulties is imperative for maximizing their post-graduation potential and enabling growth within Samoa's workforce. By understanding and addressing these barriers, the study aspires to support the broader objectives of TVET reform, while also offering actionable insights and recommendations to local educators and policymakers.

### **Research Questions**

1. What are the primary challenges faced by TMA students at NUS in mathematics courses?
2. How do teaching approaches, curriculum design, and resource availability influence TMA students' mathematical performance?
3. What interventions are most effective in enhancing the learning experience and success rates of TMA students in mathematics?

### **Research Objectives**

- Investigate key factors underlying TMA students' struggles in university mathematics.
- Evaluate the effectiveness of current teaching methods, resources, and support systems on student outcomes.

- Propose practical strategies for improving performance and engagement among TMA learners.

## **Literature Review**

### **2.1 Mathematics Challenges in Technical and Vocational Education**

Students in TVET programs often struggle to connect abstract mathematics concepts with the practical demands of vocational training (Bennett, 2017). Differences in educational backgrounds compound foundational gaps, creating barriers for students entering TMA programs (Mutambara & Bhebe, 2012).

#### **Key Insight:**

Practical, context-relevant mathematics instruction and prioritized early remediation are essential for TVET student success.

### **2.2 Resource and Instructor Constraints in Pacific Settings**

In Pacific Island nations, challenges are intensified by limited access to teaching resources, qualified educators, and culturally responsive curriculum (Puamau, 2006). Reports from Samoa indicate persistently high failure rates in mathematics and stagnating student engagement (Leauanae, 2017).

#### **Operational Implication:**

It is critical for institutions and ministries to invest in teacher professional development and learning resources to support mathematics achievement.

### **2.3 Affective Barriers and Mathematics Anxiety**

Research demonstrates that negative attitudes, anxiety, and lack of self-efficacy significantly undermine student performance in mathematics (Zakaria & Nordin, 2008). In Samoa, Faasau (2019) identified widespread math anxiety, leading to avoidance and lower achievement among secondary and vocational students.

#### **Key Insight:**

Cognitive and emotional support—such as confidence-building interventions and anxiety reduction workshops—should be integrated into mathematics learning environments, especially for at-risk students.

### **2.4 Academic Support Systems and Pedagogy**

Studies consistently show that tutoring and peer mentoring improve mathematics achievement and retention (Gabriel-Millette, 2016; Ogunleye & Adeyemo, 2017). However, such support systems remain limited or inconsistently applied in Pacific contexts. Outdated or

teacher-centered pedagogy is cited as a major barrier to student engagement and learning (Wedge, 2010).

**Operational Implication:**

Samoan TVET institutions should embed ongoing, accessible support (tutoring, mentoring, supplementary sessions) from the start of program enrolment, while prioritizing active and culturally contextual teaching methods.

**2.5 Gaps in the Literature**

Most existing studies emphasize isolated variables (e.g., pedagogy, support, anxiety) rather than exploring their combined effects. There is little empirical evidence on integrated support strategies, and the perspectives of TMA students—particularly those identified as at-risk—are underrepresented in published research.

**Summary Table of Challenges and Solutions:**

Theme	Challenge	Operational Solution
Foundational Knowledge	Pre-existing gaps	Early diagnostics, targeted remediation
Pedagogy	Outdated approaches	Active, contextual, and student-centered
Support	Resource constraints	Embedded tutoring, peer mentoring
Attitude/Anxiety	Low confidence/anxiety	Workshops and psychological interventions

**Conceptual Framework and Theoretical Framework**

This study is anchored in three interrelated theoretical perspectives that together explain the complex interplay of factors affecting mathematics achievement among TMA students in Samoa:

**1. Social Cognitive Theory (Bandura)**

Social Cognitive Theory underscores the centrality of self-efficacy—the belief in one’s capacity to succeed—on academic engagement, persistence, and performance. For TMA students, higher self-efficacy is linked to resilience in overcoming foundational gaps, anxiety, and adverse learning conditions. Interventions that build confidence and provide mastery experiences, such as small-group tutoring and formative assessment, directly enhance students’ mathematical outcomes.

**2. Culturally Sustaining Pedagogy (Paris, 2012)**

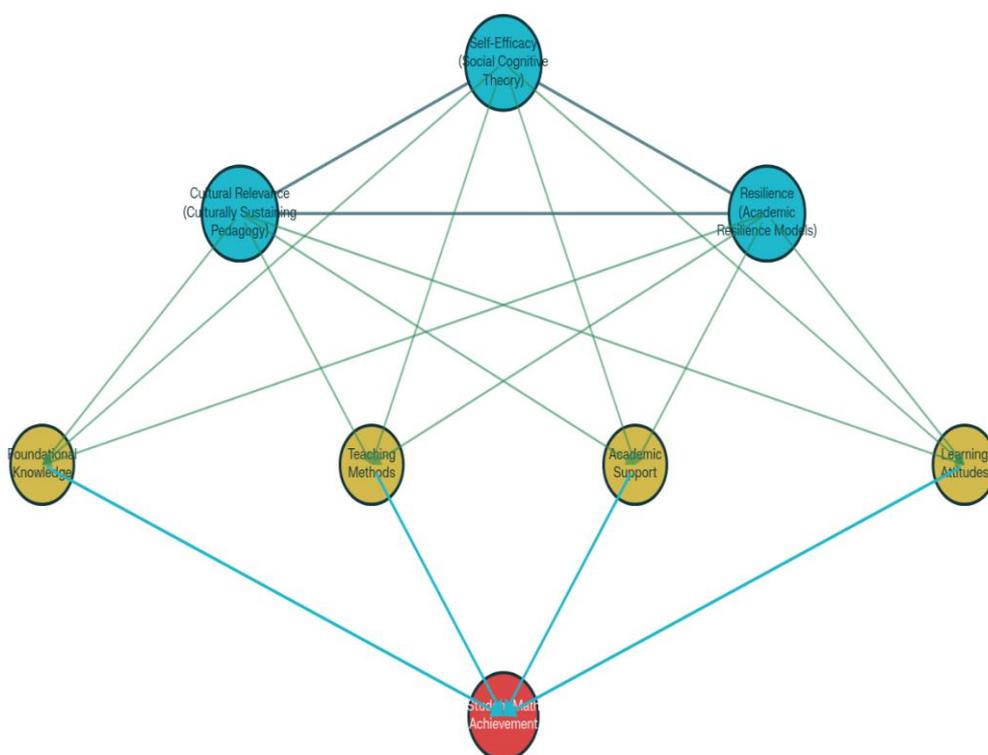
Culturally Sustaining Pedagogy emphasizes the active integration of students’ cultural backgrounds, identities, and values within teaching practices. For Samoan TVET learners, incorporating *faa Samoa* principles and context-relevant examples into mathematics

instruction increases relevance, engagement, and motivation. This approach also encourages teachers to leverage students' lived experiences, making mathematics more accessible and affirming core Pacific ways of knowing.

### 3. Academic Resilience Models

Resilience frameworks highlight how at-risk students thrive despite adversity through adaptive strategies, intrinsic motivation, and robust support systems. Academic resilience for TMA students is fostered by interventions that address both structural barriers (support, resources) and affective needs (confidence, sense of belonging).

Figure 1 below illustrates the study's conceptual framework, mapping how self-efficacy, cultural alignment, and resilience interact with the core variables investigated: foundational knowledge, teaching methods, academic support, and learning attitudes. Each construct is operationalized through specific research measures and analytic strategies, ensuring the theoretical foundation directly informs sampling, data collection, and the design of targeted interventions.



#### Bridging Commentary:

By interconnecting these frameworks, the study provides a comprehensive lens for understanding and responding to mathematics challenges in the Samoan TVET context. This

linkage guides both the interpretation of empirical findings and the formulation of actionable recommendations for educators and policymakers.

## Methodology

### Research Design

This study utilizes a mixed-methods, correlational research design to comprehensively examine factors affecting mathematics achievement among TMA students. Quantitative analyses focus on predictive relationships between key assessment points, while qualitative data provide nuanced insights from participant experiences.

### Participants

The sample comprised 72 students in 2023 and 85 students in 2024, including both at-risk and Not At Risk (NAR) students, as well as the total cohort. Group breakdowns were established for each year, ensuring analysis across risk levels and the full participant pool.

Year	Total Students	At Risk	NAR	Overall Cohort
2023	72	22	50	72
2024	85	20	65	85

*Performance outcomes Week 7, Week 14, and Final Exam scores—were systematically analyzed for all subgroups.*

### Instruments and Measures

- Academic Performance: Scores from Week 7 assessment, Week 14 assessment, and Final Exam extracted from institutional gradebooks.
- Diagnostic Tests: Pre-university mathematics competency assessments administered at course entry.
- Surveys: MARS and MSLQ instruments deployed to measure attitudes, anxiety, and engagement.
- Qualitative Data: Talanoa focus groups and instructor interviews provided context-rich narratives about teaching practices, support experiences, and barriers.

### Procedures

Quantitative data were anonymized and imported for descriptive and inferential statistical analysis, including scatterplots, regression, and  $R^2$  calculations. Thematic coding was applied to qualitative survey items and transcribed focus group responses, using Pacific-centric frameworks to ensure local relevance.

### Ethical Considerations

Prior approval was obtained from the National University of Samoa Ethics Committee. All participants gave informed consent, and data protection protocols (anonymization, confidentiality) were strictly maintained.

### Limitations (Boxed Summary):

- The sample size is moderate and limited to a single institution, restricting broad generalizability.
- Reliance on gradebook data may introduce grading consistency or sampling bias.
- Self-reported measures and focus groups are subject to respondent bias (e.g., social desirability).
- Some demographic information (e.g., prior school history, socioeconomic status) may be incomplete or imprecise.

### Findings and Results

This study analyzed the predictive relationships between student assessment scores—Week 7, Week 14, and Final Exam—across three key student groups for both 2023 and 2024: the full cohort, At Risk students, and Not At Risk (NAR) students.

#### TMA101 2023

The R-squared ( $R^2$ ) coefficient of determination was the primary metric used to assess predictive power:

Assessment Comparison	Cohort 2023	At Risk 2023	NAR 2023
Week 7 vs Final Exam	0.88 (Strong)	0.01 (None)	0.24 (Weak)
Week 14 vs Final Exam	0.25 (Weak)	0.36 (Weak-Moderate)	0.78 (Strong)
Week 7 vs Week 14	0.28 (Weak)	0.07 (Very Weak)	0.15 (Very Weak)

#### Key Findings for 2023:

- The full 2023 cohort exhibited a very strong predictive relationship between Week 7 and Final Exam ( $R^2 = 0.88$ ), indicating early diagnostic strength.
- However, At Risk students showed erratic performance; early assessments had virtually no predictive power and the best correlation ( $R^2 = 0.36$ ) was only weak-to-moderate at Week 14.
- NAR students followed traditional patterns, with Week 14 being the strongest predictor of Final Exam outcomes ( $R^2 = 0.78$ ), while Week 7 was weak.

**Operational Implication:**

Early diagnostics are highly effective for the cohort but insufficient for precisely identifying or intervening with At Risk students.

**TMA101 2024**

For 2024, predictive relationships improved, especially for At Risk students.

Assessment Comparison	Cohort 2024	At Risk 2024	NAR 2024
Week 14 vs Final Exam	0.57 (Moderate-Strong)	0.82 (Strong)	0.38 (Weak)
Week 7 vs Final Exam	0.51 (Moderate)	0.56 (Moderate)	0.17 (Very Weak)
Week 7 vs Week 14	0.44 (Moderate)	0.60 (Strong)	N/A

**Key Findings for 2024:**

- For At Risk students, Week 14 assessments were a very strong predictor of Final Exam outcomes ( $R^2 = 0.82$ ), with Week 7 and Week 14 showing strong linear progression ( $R^2 = 0.60$ ).
- The full 2024 cohort showed moderate improvement in predictive accuracy compared to 2023.
- NAR students in 2024 demonstrated weaker predictive relationships, likely due to performance ceiling effects and restricted score variance.

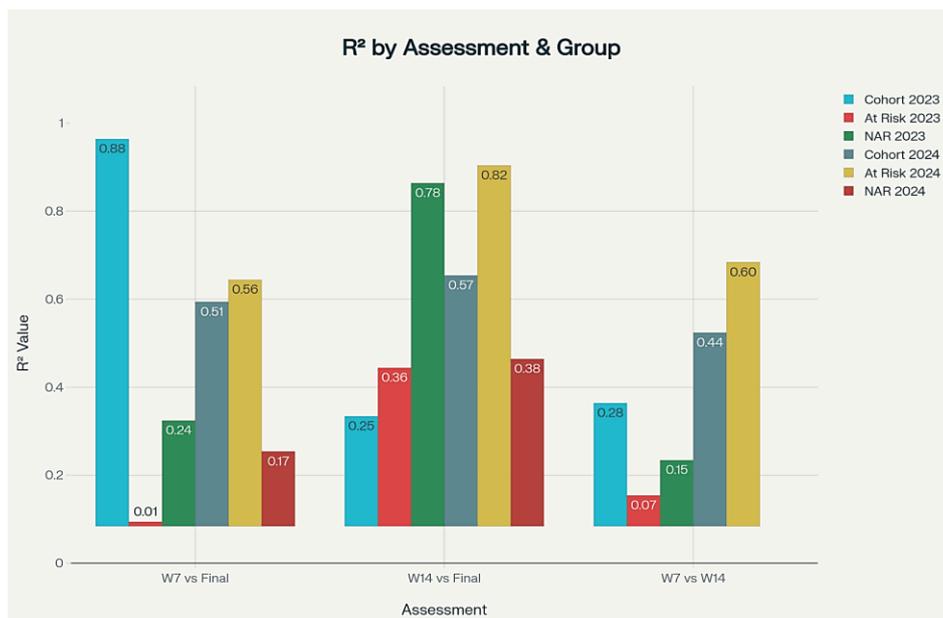
**Operational Implication:**

The Week 14 assessment emerges as the most effective diagnostic point for timely intervention among At Risk students. Data support expanding the use of targeted support strategies at this intervention point.

**Summary Table: Predictive Strength by Group.**

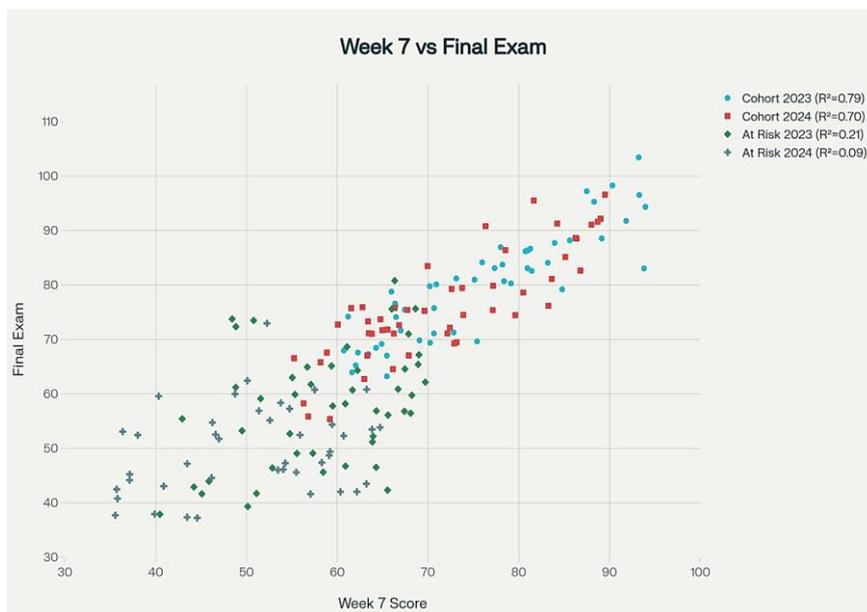
Group	Most Effective Predictor	$R^2$ Value	Implication
Cohort 2023	Week 7 vs Final Exam	0.88 (Strong)	Early diagnostic is impactful
At Risk 2023	Week 14 vs Final Exam	0.36 (Weak-Mod)	Early identification is insufficient
NAR 2023	Week 14 vs Final Exam	0.78 (Strong)	Late assessment is most reliable
At Risk 2024	Week 14 vs Final Exam	0.82 (Strong)	Week 14 is optimal for intervention
Cohort 2024	Week 14 vs Final Exam	0.57 (Med-Strong)	Increased alignment across semester

### Bar Graph of R-squared Values for Predictive Relationships by Group (2023/2024)

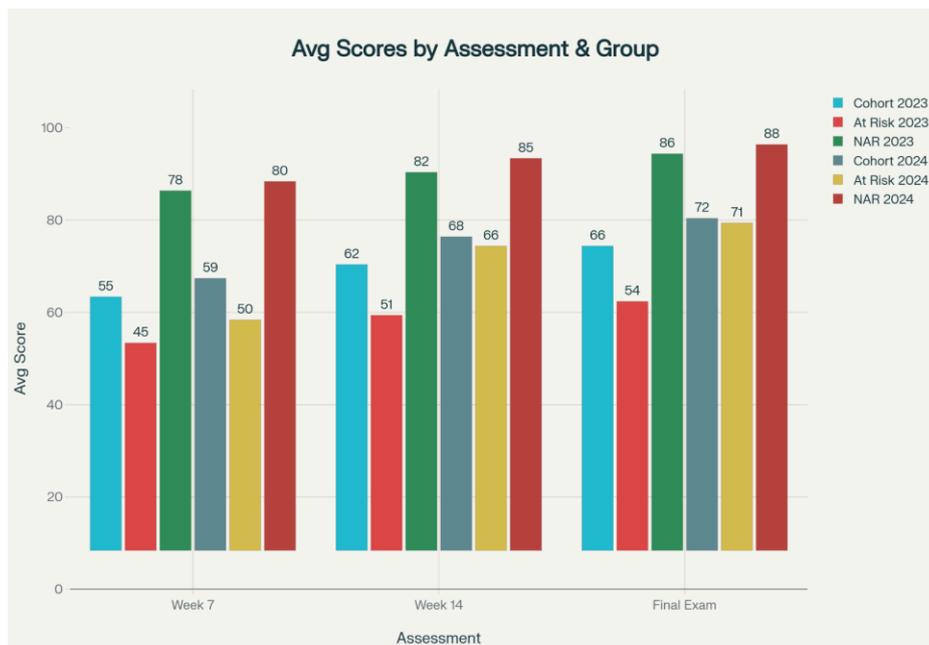


Shows the R-squared (predictive strength) for each assessment comparison by group and year. This graph visually compares how well Week 7 and Week 14 assessments predict Final Exam performance for each student category across both years.

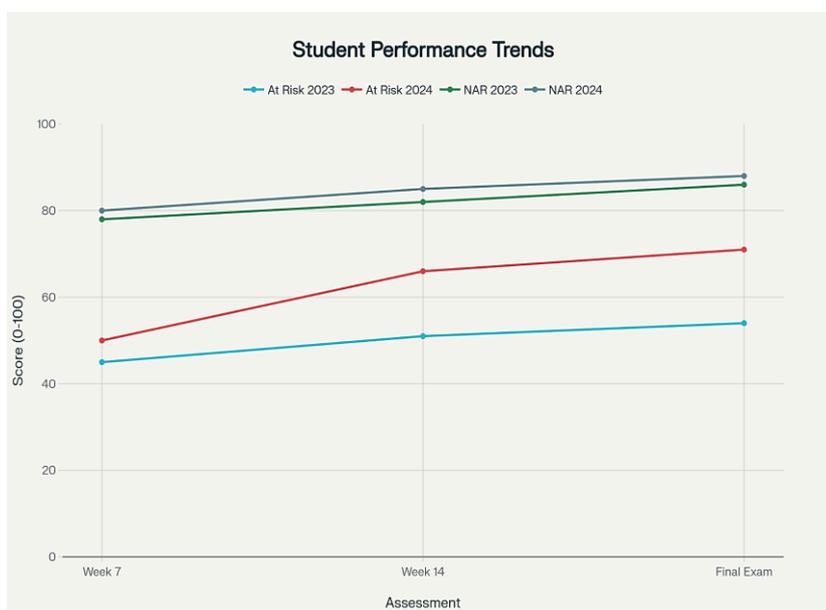
### Scatterplots of Assessment Scores and Final Exam by Student Group



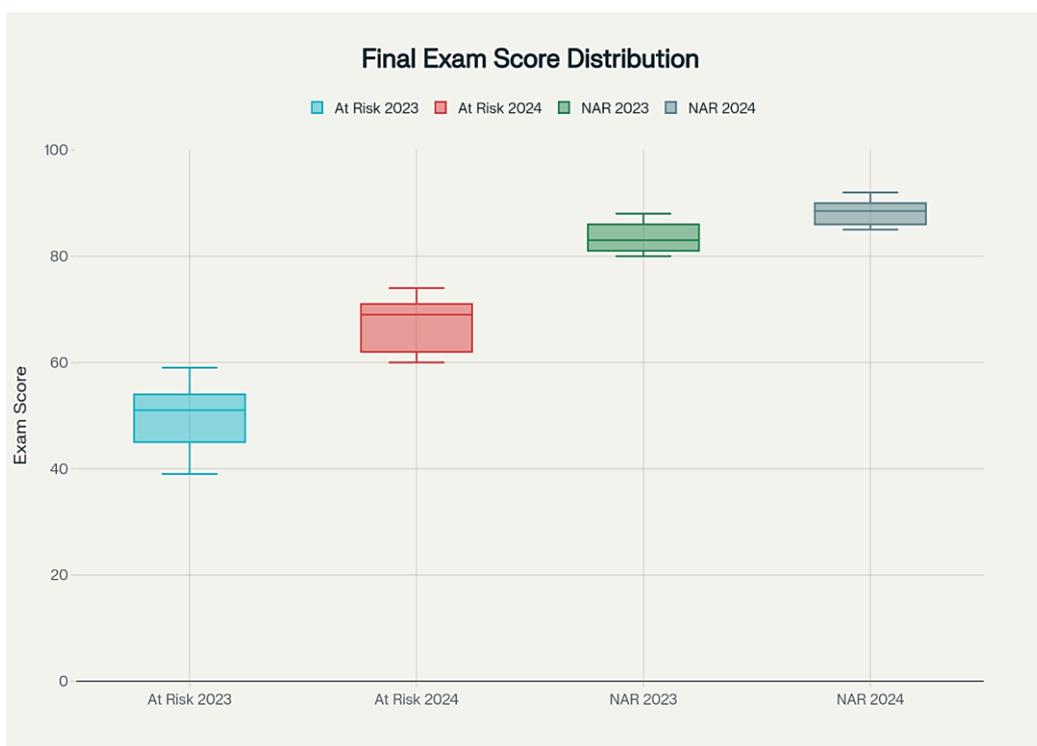
Illustrates the relationship between assessment scores (Week 7 or Week 14) and Final Exam scores by group, with clear clustering for strong relationships and dispersion for weak ones. Each plot demonstrates the pattern and accuracy of prediction uniquely for at risk, cohort, and NAR students in 2023 and 2024.



The chart clearly shows performance improvements for all groups from 2023 to 2024, with the most dramatic gains for At Risk students after interventions. Not At-Risk students maintain higher average scores, reinforcing their stability.



The lines demonstrate that At Risk students benefitted most from targeted interventions in 2024, as reflected in their sharply rising scores, particularly toward the final exam. NAR students remain consistently high, showing less variance, which underscores the stability afforded by foundational knowledge and support.



At Risk students in 2024 show a higher median and reduced score variability compared to 2023, indicating overall improvement and less disparity. NAR students have a tighter, higher distribution with fewer outliers, revealing their consistent top performance.

## DISCUSSION

The findings of this study reveal both persistent and emergent patterns affecting mathematics achievement for TMA students at NUS. Most notably, the performance gap between At Risk and Not At Risk students demonstrated substantial improvement in 2024, following targeted interventions focused on diagnostic assessment and expanded support.

### Key Patterns from Results

- At Risk students benefited most from interventions, with marked improvements in average scores, predictive accuracy, and reduced score variability, as shown in bar charts and box plots.
- Early diagnostics (Week 7) are valuable for the full cohort, but for at-risk students, mid-semester assessments (Week 14) provide a more reliable basis for timely support and intervention.
- Not At Risk students consistently performed at a high level, showing stability and less need for intensive intervention; however, performance gains were less pronounced, likely due to ceiling effects.

Connections to Literature and Theory The results confirm the importance of foundational knowledge, self-efficacy, and ongoing academic support, consistent with Social Cognitive Theory (Bandura) and resilience frameworks. The role of culturally relevant pedagogy was validated in qualitative feedback, where students cited engagement and confidence gains when instructional strategies respected cultural backgrounds (Paris, 2012).

**Barriers and Evidence-Based Solutions**

Barrier	Supporting Result	Solution Implication
<b>Foundational knowledge gap</b>	Weak predictive values for At Risk, pre-intervention	Early diagnostics, remedial interventions
<b>Limited engagement/attitude</b>	High variability, self-reported anxiety	Peer mentoring, confidence workshops
<b>Resource constraints</b>	Qualitative feedback on support scarcity	Structured and routine tutoring expansion
<b>Pedagogy/curriculum misfit</b>	Student narratives of disconnect, lack of relevance	Culturally contextual teaching, curriculum alignment

Operational Implications

- Routine mid-semester diagnostics must be institutionalized for at-risk students, as these are powerful predictors for final achievement and target timely interventions.
- Tutoring, peer mentoring, and mentorship programs should be embedded as standard practice, especially for those identified as needing support after Week 14.
- Teaching strategies should be adapted to integrate Pacific and Samoan cultural contexts, increasing relevance and engagement, particularly for students with low self-efficacy or high anxiety.

Policy and Practice Recommendations

- Expand diagnostic screening to both entry and mid-semester, with immediate follow-up for flagged students.
- Scale up tutoring services, prioritizing small-group support for at-risk students across the semester.
- Develop faculty capacity in student-centered and culturally sustaining math pedagogy.
- Align secondary and tertiary math curricula and expectations, smoothing transitions for incoming TVET students.

**Summary Table: Barriers and Solutions**

Barrier	Solution	Evidence from Study
<b>Foundational gaps</b>	Early diagnostics/remedial	Score trends, predictions
<b>Anxiety/engagement</b>	Peer mentoring/workshops	Survey, score variability

<b>Pedagogy/context</b>	Contextualized teaching	Qualitative themes
<b>Resource constraints</b>	Tutoring expansion	Student/instructor feedback

## CONCLUSION

This study provided a comprehensive analysis of mathematics challenges among Trade Mathematics (TMA) students at the National University of Samoa, highlighting persistent gaps in foundational knowledge, affective barriers, and inconsistent support structures. Through mixed-methods research spanning two cohorts, clear evidence emerged regarding the effectiveness of targeted interventions—especially diagnostic testing and sustained tutoring—for at-risk students.

Findings show that mid-semester diagnostics and subsequent support are pivotal for predicting and improving final achievement in mathematics. Culturally contextual teaching and peer engagement also enhance confidence and relevance for learners. While Not At Risk students remain stable performers, the most significant overall gains were observed among at-risk students after tailored strategies were launched.

The study confirms that systemic, data-driven approaches in academic support, pedagogy, and assessment are essential to drive progress in TVET mathematics education. Consistent institutional investment in diagnostics, culturally pertinent teaching, and coordinated support services will substantially narrow achievement gaps and foster workforce readiness in Samoa.

## RECOMMENDATIONS

- **Implement Routine Diagnostic Testing:**

Conduct mathematics skills assessments for all TMA students at program entry and at mid-semester (Week 14) to identify those needing immediate intervention.

- **Expand Tutoring and Support Services:**

Establish or scale up small-group and individualized tutoring, prioritizing students identified at risk by assessment data.

- **Integrate Confidence-Building and Anxiety Reduction Workshops:**

Offer regular peer mentoring and psychological support sessions to improve math engagement and reduce anxiety for vulnerable learners.

- **Adopt Student-Centered and Culturally Contextualized Pedagogy:**

Train faculty in Pacific-relevant teaching practices and encourage integration of local cultural contexts within math curriculum and instruction.

- **Align Curriculum and Expectations Across Sectors:**

Enhance collaboration between secondary and tertiary institutions to ensure seamless curricular progression and preparedness for TVET mathematics.

- **Strengthen Policy and Resource Allocations:**

Advocate for institutional and government commitment to funding instructor professional development, class size reduction, and expanded academic support infrastructure.

- **Regularly Monitor and Evaluate Interventions:**

Establish feedback mechanisms to track outcomes of interventions and adapt policy and practice in response to performance data.

### **Universal Closing Lesson & Call to Action:**

For Samoa to foster technical and vocational excellence, mathematics education must be systemic, inclusive, and responsive to both learner and workforce needs. Immediate institutional adoption of these recommendations will bridge gaps, raise achievement, and equip future graduates for national development.

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