MANAGING INEVITABLE BIAS: A FRAMEWORK FOR CULTURALLY RESPONSIVE ASSESSMENT IN MATHEMATICS TEACHER EDUCATION

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This study challenges the assumption that cultural bias in assessment can be eliminated through awareness and design. Through interviews with five educators of pre-service teachers of subjects such as mathematics, this paper demonstrates that bias is a reality to be managed rather than eliminated. Findings reveal that: (1) online environments facilitate more consistent cultural integration through systematic planning than face-to-face adjustments; (2) unlimited cultural integration undermines assessment consistency; and (3) technology amplifies cultural advantages in unpredictable ways. This paper proposes a framework for systematic bias management by transparently distributing advantages across assessment sequences, making cultural assumptions explicit, and involving cultural representatives in evaluation design.

INTRODUCTION

Traditional assessment methods systematically disadvantage learners from non-dominant cultural backgrounds (Solano-Flores & Nelson-Barber, 2001). The problem isn't cultural diversity itself but how assessment responds to it. When evaluation methods fail to account for cultural differences in knowledge demonstration, communication patterns, and learning preferences, they exacerbate educational inequity (Shepard, 2019). These challenges are no less likely to present themselves in mathematics teacher education. Although mathematics has historically been positioned as culturally neutral, universal and objective, research suggests that mathematical thinking is deeply culturally situated, with different traditions emphasizing varied approaches to problem-solving, reasoning, and proof (Bishop, 1991). However, assessment approaches in teacher education programs—deductive proof, individual problem-solving, written symbolic expression, for example—privilege Western approaches to mathematical thinking and practices. At the same time, future mathematics teachers might (wrongly) think that these approaches represent 'real' mathematics while other cultural practices are supplementary (de Freitas, 2008).

Contemporary beliefs assume that cultural bias in assessment can be eliminated through cultural awareness training and careful design (Gay, 2000). Professional development programs emphasize real-time cultural recognition and immediate responsiveness as solutions (Brown-Jeffy & Cooper, 2011). This assumption influences research promoting comprehensive cultural integration without addressing how such integration functions within structured evaluation contexts (Paris, 2021).

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This study challenges that foundational assumption. What if cultural bias in assessment is intrinsic and not eliminable? After all, every assessment task privileges certain cultural ways of knowing while disadvantaging others, not due to inadequate design but as an intrinsic characteristic of evaluation within cultural contexts. The question is not how to eliminate bias but how to manage it equitably and transparently. This study aims to address three questions: (1) How do educators implement culturally responsive assessment and what challenges emerge? (2) How do cultural integration strategies differ between face-to-face and online environments? (3) What systematic approaches can manage cultural bias while maintaining assessment integrity?

THEORETICAL FRAMEWORK

The Elimination Assumption

Most assessment frameworks (e.g., Lucas & Villegas, 2013) assume that cultural bias can be eliminated through sufficient awareness and careful design. Gay (2000) argues that effective assessment must acknowledge culture's influence on learning, implying that such acknowledgement allows bias removal. However, when assessment privileges one mathematical tradition while marginalizing others, it perpetuates what Powell and Frankenstein (1997) call 'Eurocentrism in mathematics education'.

The Face-to-Face Assumption

Literature consistently emphasizes face-to-face environments for cultural responsiveness, arguing that immediate access to cultural cues enables effective integration (Nasir & Cooks, 2009). This assumption rose during COVID-19, with emergency remote teaching framed as inferior to face-to-face instruction (Hodges et al., 2024). However, comparative research on cultural responsiveness across modalities remains limited and assumptions about face-to-face advantage lack empirical support in assessment contexts.

Research Gap

The elimination assumption implies that frameworks rarely address whether neutral evaluation across diverse mathematical practices is achievable. On the other hand, the face-to-face assumption lacks empirical verification in assessment practices (Meaney et al., 2012). Also, despite growing recognition of culturally responsive assessment's importance, gaps limit effective implementation. Most research examines K-12 contexts, so questions regarding its adaptation in higher education persist. While theoretical frameworks vary, empirical studies examining actual implementation remain limited (Alt & Raichel, 2021). The field lacks understanding of how cultural responsiveness operates across learning environments, in terms of systematic assessment implementation rather than spontaneous cultural recognition. This study addresses these gaps by examining practitioners' lived experiences implementing culturally responsive formative assessment across modalities, focusing on tensions between theoretical ideals and practical constraints that current literature inadequately addresses.

METHODOLOGY

This qualitative study employed semi-structured interviews with five academics at an Australian university. Ethics approval (Victoria University HRE16-295) was obtained prior to participant recruitment. Participants were selected for their dual role as practitioners implementing culturally responsive assessment and educators preparing pre-service teachers, including those specializing in mathematics. All participants held doctorates, possessing 4-34 years of face-to-face teaching experience and 3 years of online experience (primarily post-COVID). Three participants had international teaching experience in Europe, with one also having taught in South America. All taught pedagogy, inclusive education, and cultural diversity courses in the initial teacher education program. One-on-one semi-structured interviews (45-60 minutes via Zoom in September-October 2023) focused on exploring moments when cultural differences affected assessment outcomes, concrete modifications made for different populations, and practical differences between modalities. This allowed us to identify actual strategies and barriers rather than theoretical knowledge.

Analysis followed Braun and Clarke's (2022) six-phase thematic analysis: familiarization through multiple readings, initial coding generated 88 codes, which were then reviewed against the original transcripts, and consolidated into three final themes. Throughout the analysis, reflexive practice was maintained through analytic memoing and discussion. Trustworthiness was established through extended engagement with transcripts, member checking, thick description, and grounding interpretations in participants' words via extensive quotations. Pseudonyms (Academic 1–5) will be used below to protect participant anonymity.

FINDINGS

Analysis revealed three interconnected patterns challenging established assumptions about culturally responsive assessment.

Systematic Planning Outperforms Reactive Recognition

Contrary to literature emphasizing face-to-face advantages for cultural recognition (Margaret, 2022), participants reported unexpected benefits from online environments' required systematic planning in mathematics and other subjects. Academic 4 explained: "I actually really appreciated the tools I had, especially the breakout rooms…with a click of a button, I could put everyone in a pair. I could make sure students were working together with different people every time, which was harder to monitor in face-to-face where students naturally gather toward familiar groups". Academic 4 further elaborated that in face-to-face settings: "I would notice moments where cultural differences affected group work and try to adjust on the spot. Online, I had to plan everything in advance, which forced me to think systematically about who was working with whom and why." In face-to-face environments, educators made approximately 3-4 reactive cultural adjustments per session, but these proved inconsistent and often missed less obvious cultural needs. Academic 2 noted that while

online teaching became more "teacher-centred," this improved systematic cultural integration: "You need to try harder in the online space…I had to build [cultural integration] into the design rather than relying on reading the room."

Cultural Hybridity Theory Breaks Down in Assessment Practice

Participants described attempting to blend diverse cultural influences in their assessment practices. Academic 1 explained: "I really tried to create a culture in the classroom which includes whatever students bring. I wanted to honour everyone's cultural background and let them express knowledge in ways that felt authentic to them." This approach aligns with what Casinader and Manathunga (2020) term cultural hybridity, the blending of diverse cultural influences to create a new understanding. However, this unlimited cultural integration made the assessment difficult to implement consistently. Students from collective knowledge cultures produced collaborative responses to individual assignments. Students from hierarchical knowledge traditions waited for explicit instruction rather than demonstrating independent analysis. Each approach was culturally valid, but they could not be evaluated using consistent criteria. This created an impossible dilemma: either force students to follow dominant cultural norms (destroying the cultural responsiveness the theory promotes) or abandon consistent evaluation standards (destroying assessment integrity). Academic 3's strategy of allowing unlimited student choice in assignment focus produced submissions where "students start with their own experience…choose any aspects like gender or ability to focus on." In teacher education contexts, this meant some students analysed specific teaching strategies, others created personal narratives about professional identity, still others developed theoretical frameworks about inclusive pedagogy. All valuable, but incomparable for evaluation purposes.

When theoretical approaches appeared to be insufficient, participants developed practical adaptations. Three strategies emerged: structured limitation (providing cultural options within defined frameworks), sequential integration (building cultural elements progressively), and peer validation (using student groups to verify assessment fairness). Academic 5 explained structured limitation: "I learned I couldn't just say 'express yourself however you want.' I started offering specific options: you can write a traditional essay, create a video presentation, or design an infographic, but here are the specific criteria for each format. The cultural flexibility is there, but within boundaries that let me evaluate fairly." The evidence reveals incompatibility between unrestricted cultural integration and systematic evaluation that current theory does not sufficiently address. Paradoxically, providing structured options with explicit criteria may better support cultural equity than unconstrained freedom, as unlimited variation makes fair evaluation impossible.

Technology Amplifies Rather Than Neutralizes Cultural Bias

While technology is widely assumed to facilitate more equitable evaluation through multiple format options (Shauna & Mélanie, 2020), our findings suggest otherwise.

Academic 4 introduced video assessment believing it offered cultural responsiveness: “I thought I was being culturally responsive by offering options. But what I saw shocked me. Students from Pacific Island backgrounds, from cultures with strong oral traditions, were highly engaged. Meanwhile, students from East Asian backgrounds really struggled. They told me it felt uncomfortable to present themselves individually on camera—it wasn't their cultural norm.” While technology required planned cultural integration, it created unanticipated cultural advantages for some students. Students from oral tradition backgrounds performed exceptionally in video assessments while those from collective knowledge cultures demonstrated lower engagement in individual video presentations despite strong performance in collaborative written work.

Performance differences varied across technological applications (Lucas & Villegas, 2013). Students from hierarchical knowledge traditions performed strongly in structured video formats but found open-ended multimedia tasks challenging. Those from visual knowledge traditions excelled in infographic assignments but had difficulty with text-based video descriptions. Each technological choice created specific cultural advantages and disadvantages across different cultural knowledge systems. Academic 2 captured the complexity: “Different cultures have different ways of collaborating. I had Chinese students who wanted to work individually first, then come together. Pacific Island students who wanted to start together and stay together throughout. How do I design group assessments that respect all these approaches while still evaluating individual contributions fairly?”

For mathematics, digital tools like GeoGebra might privilege students from visual-spatial mathematical traditions while creating barriers for students who think mathematically through symbolic manipulation. Consequently, technological mediation is not a neutral solution but a re-distribution of cultural advantage. Video explanations might advantage oral mathematical reasoning cultures while disadvantaging written analytical approaches. Providing multiple format options, rather than reducing cultural bias, may increase it by creating systematic advantages for cultures whose mathematical practices align with particular technological approaches.

These findings challenge the assumption that cultural bias can be eliminated through awareness and flexibility, suggesting that practitioners develop situated strategies not because existing frameworks are inadequate but because the intersection of cultural responsiveness and systematic evaluation creates inherent tensions requiring acknowledged management rather than assumed resolution.

SYSTEMATIC BIAS MANAGEMENT FRAMEWORK

From Elimination to Management

Our data support the assertion that all assessment contains cultural assumptions systematically advantaging some groups while disadvantaging others, not due to

insufficient design but intrinsic to evaluation within cultural contexts. The findings challenge assumptions inherent in traditional approaches to assessment design that sufficient cultural competence training and careful design can produce culturally unbiased assessment. The cases of Academics 3 and 4, who offered unlimited cultural choice and video options respectively, exemplify the challenges outlined above. We offer here a systematic bias management approach which operates on three principles derived from analysis of our participants' experiences: bias is inevitable in cultural contexts, bias can be distributed equitably, and bias effects can be made transparent. These principles are implemented through three interconnected strategies, as explained below.

Three Interconnected Strategies

Sequential Cultural Integration

Rather than attempting to make each assessment culturally neutral, this strategy ensures different cultural groups receive advantages at different points in assessment sequences. Implementation involves cultural bias mapping, where academics collaborate with cultural representatives such as students from diverse backgrounds, cultural advisors, or community members to identify which cultural approaches each assessment task privileges. For instance, individually written proof-based assessments advantage Western reasoning traditions. The assessment sequence is then set up such that a variety of tasks privilege different cultural mathematical approaches (e.g. solving cultures, oral mathematical explanation, narrative reasoning, and visual-spatial). If one assignment task requires individually-written proofs, the next might involve collaborative problem-solving which expects students to negotiate mathematical meaning together. Yet another might ask for video explanations of mathematical thinking in which oral reasoning traditions are adept.

Such sequential integration maintains consistency within individual tasks while distributing cultural advantages across the complete assessment sequences. Practical advantage and fairness would be achieved, not through treating all students identically within each assessment but by ensuring all receive equitable opportunities across the course assessment sequence.

Transparent Bias Disclosure

This strategy is concerned with making explicit cultural assumptions. Thus, in our data, Academic 4's video assessment exercise would be accompanied by transparent disclosure informing students that this format systematically advantages certain groups of students (i.e. those from oral tradition cultures) and providing preparation guidance to all students. Students will also learn that everyone will be advantaged in different types of assessment tasks. Similarly, a teacher might explain to their students that while the current proof-writing assessment might advantage students who prefer to work and reason individually, the next few assessments will advantage those who work better

collaboratively or who reason more visually. Such transparency replaces false neutrality assumptions common in traditional assessment practice.

Collaborative Cultural Validation

This third strategy engages representatives from different cultural groups in assessment design and evaluation. Collaborative evaluation might determine whether a student's narrative mathematical explanation demonstrates required understanding through culturally appropriate methods, or whether a problem-solving solution demonstrates valid mathematical thinking even if it does not follow individual proof conventions. This collaborative approach centres diverse voices in assessment, challenging power dynamics where academics from dominant backgrounds determine evaluation standards, often subconsciously. However, implementation must avoid performative inclusion by ensuring appropriate remuneration, clearly defined roles, and regular participant rotation.

IMPLICATION AND CONCLUSION

The proposed framework—featuring sequential cultural integration, transparent bias disclosure, and collaborative cultural validation—offers practical strategies for navigating tensions in acknowledging culturally-based assessment responses. These responses often reflect culturally diverse mathematical practices. This represents a shift from treating cultural bias as an individual pedagogical failure to recognizing it as a systemic reality requiring institutional approaches. Rather than forcing all students to demonstrate understanding through Western deductive proof or assuming that offering 'choice' eliminates bias, educators can systematically rotate through different mathematics cultural traditions, make these rotations transparent, and involve cultural representatives in determining whether diverse mathematical expressions demonstrate required competencies.

The methodology of this study presents some limitations. The small sample and single institutional context limit generalizability. The study captures only educators' perspectives; there are implications for future research here to investigate student voices as well. Also, the participants' online teaching experience (during the COVID-19 pandemic) reflects emergency remote teaching, which means that the pedagogical experience would be different from that of purposefully-designed online lessons. Nevertheless, the analysed data have presented some thought-provoking results which future research can follow up. The data had informed the proposal of a framework which represents a paradigm change in responding to inevitable bias inherent in (mathematics) assessments. It demonstrates a shift from pursuing impossible neutrality toward managing the inevitable bias. The framework is also practical, in shifting accountability from individual cultural competence to institutional bias management.

Practical implications include shifting professional development from emphasizing real-time cultural observation toward systematic cultural analysis and bias management capabilities. Assessment design processes must incorporate bias mapping

and sequential planning. Institutional policies must support equitable bias distribution through requirements for assessment sequence planning.

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