Using the McNamara Fallacy to Critique (Mis)representations of "Success" in Mathematics Education

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This position paper examines the phenomenon of the McNamara Fallacy to analyse flawed conceptions of "success" in mathematics learning, normalised assessment structures and their implications for mathematics education. The established presence of the McNamara Fallacy and the ramifications of this statistical fallacy provide a foundation to demonstrate its existence and parallels within mathematics education, including NAPLAN and other common assessment structures. Viewing such assessments through the lens of the McNamara Fallacy allows educators to recognise, explain, and potentially address their negative consequences.

Various forms of formal and informal assessment play a prominent role in enabling judgments to be made about students' success in learning mathematics. For example, national and international assessments such as NAPLAN tests of numeracy achievement and PISA tests of mathematical literacy provide high-level information about the effectiveness of education provision across a country or for demographic sub-groups, while classroom assessment can monitor the progress of individual students and generate feedback to inform teaching. However, the results of mathematics assessments are often used for other unintended purposes—often with damaging consequences for students, teachers, and schools.

In this paper, we apply the McNamara Fallacy to critique such assessments in mathematics education. This term was coined by sociologist Daniel Yankelovich in 1972 as an eponym for US Secretary of Defence Robert McNamara's (1961–1968) statistical approach to the Vietnam War. The McNamara Fallacy refers to the logical yet flawed tendency to draw conclusions or reach a hypothesis derived from easy-to-measure quantitative data while also disregarding important variables that are nevertheless more difficult to quantify. This statistical fallacy can lead to misleading conclusions, oversimplified perspectives, cognitive bias, distorted truth, and overconfidence in unfounded decision-making. The aim of this position paper is to use the McNamara Fallacy to analyse flawed conceptions of "success" in mathematics learning and assessment and their implications for mathematics education. This paper will first explore the origins of the McNamara Fallacy before recognising its established presence within the healthcare fields to demonstrate parallels with mathematics education. This paper will continue to investigate other possible areas of mathematics education assessment impacted by the McNamara Fallacy.

The Origins of the McNamara Fallacy

Robert McNamara (1916–2007) is noted as a great logical economist and a remarkable statistical mind with an impressive resume and many notable achievements. In 1943, McNamara enlisted as a Captain in the United States (US) Army's Department of Statistical Control, where his profound statistical methodology dramatically improved the planning and execution of aerial bombing missions during World World II (Kelleher, 2021). After three years of active duty and an elevated rank of Lieutenant Colonel, McNamara and other ex-military statisticians were recruited by the troubled giant Ford Motor Corporation (United States Department of Defence, n.d.). McNamara's considerable talents in statistical analysis and financial management were critical to the triumph of Ford's expansion and restored profit margins in post-war times (United States Department of Defence, n.d.). McNamara's planning

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and management prowess resulted in his advancement through various high-level management positions, including a short stint as the President of the Ford Corporation (Kelleher, 2021; United States Department of Defence, n.d.). Because of McNamara's prominent reputation, then US President-Elect John F. Kennedy offered McNamara a cabinet position, which saw McNamara reject the initial offer of Treasury Secretary but accept the Secretary of Defence post (O'Mahony, 2017). Despite his distinguished career up to this point, McNamara's rational and statistical approach to 'problems' is now more commonly attached to costly decisions in prosecuting the Vietnam War.

Following his former successes, McNamara continued to demonstrate his aptitude for statistical analysis and quantitative decision-making in the approach of the US to the Vietnam War. A key measure of the success of McNamara's military strategy was ensuring the number of enemy casualties and fatalities exceeded those of the US. This strategy of taking casualty and fatality figures as the measure of success led to a massive escalation of the number of US soldiers in Vietnam. However, the data used by McNamara were flawed. O'Mahony (2017) explains how "the South Vietnamese army reported what they thought the Pentagon wanted to hear—they were 'gaming' the figures—and the US did not question the numbers" (p. 281). Kelleher (2021) writes how, increasingly, the 'body count' metric became the "preferred way for US Generals to rank the effectiveness of different American combat units" (p. 260), including the determination of promotions, ensuing 'gaming' data practices in which previously recorded fatalities were re-tallied to inflate numbers.

Later, McNamara exhibited remorse and doubt in his military strategy and, as O'Mahony (2017) writes, "conceded that excessive emphasis on a single crude metric over-simplified the complexities of conflict" (p. 281). The Vietnam War was the first modern-day and significant conflict that depended upon guerrilla warfare. Guerrilla warfare refers to accumulative small-scale yet intense acts of combat via irregular methods or unconventional tactics and is typically carried out by grassroots or irregular members fighting against larger and more traditional powers (Lebo et al., 2021). Consequently, there were limitations in relying on quantitative measurements to evaluate large actions, especially when boundaries are indistinguishable, unpredictable or unstable. The complexities of people and their actions do not always fit into formerly defined boxes as times change, as do technologies, resources, and the evolution of people's motivations (O'Mahony, 2017). As the war stretched, then U.S. President Lyndon B. Johnson and McNamara's views on further strategies did not align, which was amplified by the public opposition (Kelleher, 2021; O'Mahony, 2017). McNamara resigned in 1967 and, within six months, became the President of the World Bank, where he remained until the early 1980s (United States Department of Defence, n.d.).

Despite being a capable and clever man with many prestigious posts, McNamara's reputation has been forever linked to the failure of military strategy in the Vietnam War, a "problem that did not submit itself to numerical analysis" (O'Mahony, 2017, p. 281). In coining the term, '*the McNamara Fallacy*', Yankelovich (1972) succinctly described its flawed logic as follows:

> The first step is to measure whatever can easily be measured. This is OK as far as it goes. The second step is to disregard that which can't be easily measured or to give it an arbitrary quantitative value. This is artificial and misleading. The third step is to presume that what can't be measured easily really isn't important. This is blindness. The fourth step is to say that what can't be easily measured really doesn't exist. This is suicide. (Yankelovich, 1972, as cited in O'Mahoney, 2017 pp. 281–282)

We argue that the flawed logic inherent in the McNamara Fallacy is readily observable in approaches to assessment in mathematics education and the educational practices and decisions informed by the results of these assessments. However, despite its relevance and prevalence, little literature currently connects the McNamara Fallacy to mathematics education. Nevertheless, in fields such as medicine and medical education, the McNamara Fallacy is connected to worrying trends towards inappropriate reliance on quantitative measures. In the next section, we briefly review the literature on the McNamara Fallacy from the medical field as a starting point for considering its implications for mathematics education.

The McNamara Fallacy in Medicine and Health Care

Literature sources (e.g., Hirkani, 2023; O'Mahony, 2017; Singh & Shah, 2023) within the medical field have applied the McNamara Fallacy to demonstrate the negative consequences of over-dependence on quantitative measures, including the decline of patient care, professionalism, and appropriate objectives. They contend that the complexities of medicine cannot be accounted for and controlled by crude numerical analysis. They stressed that setting harmful "arbitrary targets" (O'Mahony, 2017, p. 282) does not improve care for patients and consequently results in the neglect of other important unquantifiable attributes such as communication and compassion (O'Mahony, 2017). Similarly, Kelleher (2021) describes the dismissed 'immeasurables' within dentistry, such as clinical judgment, artistry, consistency, and manual gentleness of touch. He describes how, instead of prioritising a patient's long-term dental health, UK dentists are pressured to meet specific quotas or risk financial penalties (Kelleher, 2021). O'Mahony (2017) also describes how doctors could be pressured by "audit and quality assurance programmes … to carry out treatments that are not in the patient's best interest" (p. 282). A similar UK initiative aims to judge the overall performance of British hospitals based on overall mortality rates gleaned through specific calculations, which are subject to distortion and reality bias (O'Mahony, 2017).

All of these studies applied the McNamara Fallacy to demonstrate the propensity to select easy-to-measure variables—that disregard many other more difficult-to-measure or unconsidered variables—in the effort to make conclusive judgements about performance and professionalism. In doing so, the authors highlighted the unintended consequences that have repercussions for the everyday people cared for by health professionals. Discussing the McNamara Fallacy, Singh & Shah (2023) also describe the medical education of future doctors in India and how assessment structures that "focus on numbers alone gives the wrong message to [medical] students" (p. 3) about the profession, their medical training, and the characteristics of competent and compassionate doctors of India. For example, marks on an examination do not equate to medical students' ability to ethically "apply knowledge appropriately in the given context" with honour, integrity, or emotional intelligence, nor the ability to work in a team (Singh & Shah, 2023, p. 3). Although drawing too many literal comparisons between the fields of medicine and mathematics education is unwise, there are obvious parallels between these fields in the unintended consequences of making decisions about "success" based solely on quantitative observations of one or a few variables.

Applying the McNamara Fallacy to Mathematics Education

Many examples from the medical field share parallels with factors and experiences within current educational assessments and success metrics within mathematics education. The most obvious parallel is the continued misuse of Australia's National Assessment Program—Literacy and Numeracy (NAPLAN) regime. Since 2008, Australian students in Years 3, 5, 7, and 9 have participated in NAPLAN, a series of nationwide mandatory standardised tests that assess performance in Mathematics and English aligned with the content strands of the Australian curriculum. Though standardised assessment is a common educational tool worldwide, many doubts have been raised about NAPLAN's purpose, implementation, and perverse consequences (Thompson & Cook, 2014; Wu, 2010).

The (mis)representation of NAPLAN data also carries traits of the McNamara Fallacy. Like other standardised assessments, the test design is based on a probabilistic psychometric analysis called the Rasch model, which determines students' performance based on the probability of answering questions strategically designed to demonstrate generalised underlying traits or presumed indicators (Australian Curriculum, Assessment and Reporting Authority [ACARA], n.d.; Burtenshaw, 2022). NAPLAN's numeracy test contains approximately 40 questions to sample numerous mathematics concepts across multiple-year levels from the Australian curriculum. Despite ACARA (2010) telling parents that NAPLAN's data can "measure how their child is performing against the national average", these claims have been refuted due to statistical and measurement errors (e.g., expected margins of error) not illustrated within representations sent home to parents (Wu, 2010). Without proper explanation, the placement of dots and markers on a calibrated scale could be considered arbitrary, artificial, or misleading, as outlined by Yankelovich's (1972) descriptions of the McNamara Fallacy. These statistical considerations are better mitigated with larger collective data representations for government or system-level use. Nevertheless, similar to McNamara's strategies in the Vietnam War, this one-point-in-time data is being utilised in such a manner to draw sweeping conclusions about a student, a cohort, or an entire school, including assumptions about and factors that are not assessed.

Understanding the role of the McNamara Fallacy within NAPLAN's culture can aid in comprehending and distinguishing relevant criticisms and addressing such criticism, such as the overemphasis and overreliance on NAPLAN data to make consequential judgements. Though NAPLAN specifically focuses on mathematics, viewing its repercussions through the lens of the McNamara Fallacy shows that it prioritises particular aspects of mathematics and leads to practices that narrow the curriculum to fulfil NAPLAN's illusory objectives. Instead of supporting authentic and holistic explorations of mathematics concepts, NAPLAN preparation is often focused on fragmented content exposure, best achieved through rote-learning methods of instruction and drill-like practice (Serow et al., 2016; Thompson & Cook, 2014). Such approaches are typically void of creativity, higher-order or critical thinking, or ethical or social applicability (Klenowski & Wyatt-Smith, 2012). In many classrooms, preparation for NAPLAN also includes explicitly teaching students contingency strategies to approaching questions, such as how to narrow the multiple-choice options by removing apparent incorrect responses, and 'when in doubt, guess because at least you have a 25% chance of getting it right'. This raises questions about whether the data NAPLAN produces—though easy to measure in content and method—should be appropriately relied upon to draw broad conclusions, especially if the metrics are so readily perceived by schools as gameable. Furthermore, beyond mathematics education, critics of NAPLAN argue how its overemphasis has overshadowed and disregarded other learning areas, such as The Arts (Garvis & Pendergast, 2010). Acknowledging the impact of the McNamara Fallacy within NAPLAN's culture can help distinguish the actual challenges we face as a wider education system. The real focus of concern is not mathematics—or the perceived version of mathematics portrayed by NAPLAN interpretations—but the need to unite in addressing the flaws associated with the McNamara Fallacy.

The parallelism between the medical field and the education system continues with the findings and claims about the harmful or unintended consequences of flawed conclusions fuelled by the McNamara Fallacy. Much like NAPLAN, initiatives in health care were driven by expectations of accountability and measurements for comparison purposes to determine whether the country can have confidence in their systems (O'Mahony, 2017; Singh & Shah, 2023). However, simplified initiatives that could not capture the complexities of medical and patient care have provoked perverse professional cultures, misallocation of foci, and oversimplified statistics with far-reaching ramifications (O'Mahony, 2017; Singh & Shah, 2023). A 2015 U.K. report, 'Uses and Abuses of Performance Data in Healthcare', listed various consequences of metric-based clinical targets, including tunnel vision, inequity, bullying, erosion of professional motivation, gaming of data, and deflection from lessfavourable data (Shaw et al., 2015). Mathematics education is witnessing similar claims in the narrowing of curriculum, the possibility of wasted resources, the commodification of schools, oversimplified league tables, unsubstantiated comparison disregarding natural cohort variances (e.g., per school, per cohort, etc.), and questioning whether teachers core business is education or to fulfil political or neoliberal agendas (Klenowski & Wyatt-Smith, 2012; Serow et al., 2016; Thompson & Cook, 2014; Wu, 2010). Both fields have seen the upsurge of manipulated data, the media's misguided attention, public "naming and shaming", obsessive data overuse, and small-unit data analysis unfitting to its collection's intent (O'Mahony, 2017; Klenowski & Wyatt-Smith, 2012; Serow et al., 2016; Singh & Shah, 2023). Serow et al. (2016) conclude that currently, "the value of mathematics to society is reflected in the extent to which it is externally accessed—that is assessed by agents external to the classroom and outside of the teachers' control" (p. 239). Daliri-Ngametua and Hardy (2022) write how NAPLAN's 'performativity' has resulted in the demoralisation of teachers, teacher dropout, and the 'naturalisation' of accountability discourses and 'dataveillance'. Medical and health professionals from multiple countries share similar concerns about the consequences of directives and initiatives that fall short to statistical fallacies. The same could be said about NAPLAN, as other countries (like the US and the UK) have noted similar unintended consequences from their standardised testing regimes years before Australia initially decided to go down this path (Hursh, 2005).

Examining the shared parallels between flawed measurement metrics in the medical field and NAPLAN demonstrates that the McNamara Fallacy exists within the landscape of mathematics education. Nevertheless, NAPLAN merely serves as a starting point. Other instances of the fallacy persist within conventional or widely accepted assessment structures in mathematics education. The following section aims to shed light on these additional examples for consideration.

Applying the McNamara Fallacy to Mathematics Education Assessment

The misleading logic of the McNamara Fallacy is evident within common assessment methods adopted in mathematics classrooms. This includes the tradition of mathematics exams that quiz students on fragmented mathematical content or selective mathematical activities yet are then used to form overarching conclusions about students' mathematical capabilities (Watt, 2005). Burtenshaw (2023) contends that such traditional approaches to mathematics learning and popular methods of data collection are possibly intertwined with deeply engrained beliefs or behaviourist ideologies, which suggest learning is achieved through the replication or reproduction of rules or procedures and demonstrated through performance that is "distinctly observable and objectively measurable" (p. 125). Objectivity continues to be a highly valued and widely acknowledged characteristic of reliable, "good" assessment (Watt, 2005; Shepard, 2000; Zane, 2009). However, objectivity may not necessarily warrant the degree of emphasis it receives. Nonetheless, an inherent aspect of objectivity lies in its facilitation of straightforward measurement, achieved through established limits, defined properties, and reduced chances for subjective complexities. The marking of right and wrong answers to exam questions could be considered an easy method to measure learning, especially if the purpose of such questions is to determine whether a specific skill or chunk of knowledge is demonstrated. However, this approach to measuring mathematics learning only skims the surface of what mathematics is and broader mathematical capabilities.

An inherent aspect of the McNamara Fallacy involves a cognitive bias wherein selected metrics are sufficient or appropriate enough to draw broad conclusions. This can be seen through narrow assessments like exams being relied upon too heavily to determine students' overall mathematical proficiency. Watt (2005) found an astounding overreliance on written tests despite research participants also indicating how "traditional mathematics tests cannot be used to infer more general mathematical ability" (p. 23). Not only does this continue to minimise what mathematics and mathematics learning entails, but the possible inaccuracies of such judgment formation can contribute to students' beliefs about themselves and their mathematical abilities, reinforcing values, attitudes, and opportunities in life beyond the mathematics classroom (Nardi & Steward, 2003; Thanheiser, 2023). Yet, such judgments and measures are often collated into assigning grades on report cards. These codified A–E grades only further contribute to oversimplified measures that construct broad assumptions with far-reaching effects. Clarke (1997) writes how grades are a "means of coding assessment information" and how the condensing and categorising into one single grade or score sacrifices the all-encompassed "detail that might contribute most constructively to the subsequent actions of teacher, student, or parent" (p. 65). Therefore, this also raises questions about whether the purposes of assessment are retained when afflicted by the McNamara Fallacy and if reporting structures might also be cultivating the McNamara Fallacy.

In Australia, teachers of mathematics are legally required to report to the Australian Curriculum's Achievement Standard for a student's specific year level (Department of Education, 2023). The Achievement Standards identify what must be measured, and—viewed through the lens of the McNamara Fallacy—what is therefore important. However, the mathematics Achievement Standards underscore a predominant focus on the output of skills and content, characterised by a limited range of objective-inclined verbs. A preliminary comparison with Achievement Standards from the English curriculum, for example, hints at chances for experimentation, the incorporation of dispositions, fostering critical orientations, enabling student autonomy in the exploration of content and a broader array of verbs, some of which are not purely objective (ACARA, 2022a). The choice of words to describe an Achievement Standard could subliminally reinforce actions and beliefs that prompt certain forms of assessment to ascertain student mathematical 'achievement'. For example, the verb 'experiment' is within the Years 9 and 10 English Achievement Standards but not within the Mathematics Achievement Standard (ACARA, 2022b). Across all year levels' Achievement Standards for Mathematics, the verb 'experiment' is only stated once within the Year 3 Achievement Standard.

Long since industrialised approaches to mathematics learning were the only option, cognitive science and mathematics education research has repeatedly found the importance of constructivist, explorative and meaning-making approaches to learning mathematics (Shepard, 2000; Thanheiser, 2023). This includes similar themes of experimentation, problem-solving, critical thinking, learning in communities of practice, and the impact of attitudes and dispositions (Thanheiser, 2023). These traits and characteristics of mathematics learning denote more complexity in thinking and acting and, therefore, more complexity in determining or assessing such learning. Teachers may find embedding research-informed pedagogical practices that require more complex and creative approaches to mathematics assessment more challenging if these approaches are not adequately represented in the wording of the curriculum's Achievement Standards. Here, we observe the potential effects of McNamara's Fallacy, which suggests "what can't be measured easily really isn't important" or does not exist. Mathematics education needs to move on from such flawed prioritisation of the easy-to-measure metrics to consider more accurate and more holistic alternative approaches to assessment.

Conclusions and Implications for Mathematics Education

Clarke (1997) writes how "assessment should model the mathematical activity we value" (p. 8). Mathematics is seldom performed in isolation without context, nor rarely is mathematics beyond the classroom approached in a singular way with a singular outcome—or alternatively, easy solutions for easy problems. Assessment—formative or summative—should be seen as the opportunity to gauge how well students can handle the messy, ill-structured real world in novel yet relevant ways, instead of atomised knowledge and decontextualised behaviours (Clarke, 1997; Zane, 2009). Therefore, it seems fit that measures of mathematics learning should be complex enough to capture the complexities of student thinking and acting. That is not to say such an assessment does not exist. There are many examples of good assessment practices in mathematics that measure the complexities of mathematical learning and qualitative elements of performance. This could include the *MCTP Assessment Alternatives in Mathematics* book written by David Clarke and published as part of the Mathematics Curriculum and Teaching Program (MCTP) in the 1980s. The Language of Functions and Graphs package was developed by the Shell Centre for Mathematical Education in Nottingham around the same time. These assessment examples allow for the complexities of mathematics learning to be captured. Clarke (1997) writes how, in the process of assessment, it is "the students' responsibility to demonstrate understanding and the teacher's responsibility to provide the opportunity and the means for that demonstration" (p. 24). However, we need to consider the barriers preventing this, such as the mathematics education assessments' susceptibility to the McNamara Fallacy.

The McNamara Fallacy plays a role within mathematics education assessment, and the ramifications stretch far beyond assessment, such as the worth placed on measurement and metrics, the illustration of values and the portrayal of messages—explicit or hidden. For example, suppose the selection of mathematical content and the methods of measuring content are grounded purely by the logical preference to measure what is easy to measure (or not). In that case, this communicates many hidden messages to students about mathematics, the classroom and mathematics education. Furthermore, narrow metrics provide narrow opportunities for success and narrow perceptions of success in mathematics education. Narrow opportunities and perceptions of success play a role in students' developing beliefs about themselves and their mathematical abilities, reinforcing values, attitudes, and opportunities in life beyond the mathematics classroom (Nardi & Steward, 2003; Thanheiser, 2023).

Assessment methods, such as exams and standardised testing, have their place in the education system's toolkits. However, the misuse and overconfidence in the measures and consequential data is a problem. We need to remind teachers that they have agency in their classrooms, and good examples of assessment practice will reveal the valuable and valued thinking that students do. But, for these alternatives to be considered, we must also become comfortable calling out the status quo and flawed statistical decision-making, such as what the McNamara Fallacy describes. As Thanheiser (2023) notes, this may include "dismantling structures that impede student success and participation rather than setting achievement, or lack thereof, at the feet of students" (p. 6). What is normalised is not necessarily right.

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