Teachers' Conceptions of the Term '*Success*' in Mathematics Classrooms

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'*Success*' is a frequently cited yet ambiguously defined term in mathematics education, often carrying contradictory meanings and messages. We surveyed 139 Australian teachers of mathematics to determine their conceptions of '*success'*. This paper documents teachers' responses to an alternate word or phrase for '*success*'. Thematic analysis highlighted teachers' consistent conceptions of '*success*' as mathematical proficiency and underscored the critical omission of productive dispositions from the Australian Curriculum's mathematical proficiency. These findings open conversations about '*success'* to encourage more positive, productive engagement with mathematics.

'Success' is frequently cited within education research and government policies as the ultimate ambition of schooling (e.g. Department of Education, Skills and Employment, 2019; Maxwell, 2009; Peteros, 2019; York et al., 2015). However, many contradictory messages exist about what '*success'* in mathematics education is and how '*success'* is determined. For example, curriculum documents might point to the need for creative problem-solvers and critical thinkers to embrace the future's unknowns. Yet, '*success'* is often determined through assessment of knowledge and skills that can be memorised, easily quantified, and objectively measured (Klenowski & Wyatt-Smith, 2012). This example is just one illustration of how '*success'* might be conceived. Various conceptions of '*success'* in mathematics education are at the core of a research project currently underway that is interrogating the meaning of '*success'*, according to teachers. The aim of this paper is to explore teachers' conceptions of the term '*success*' in mathematics classrooms by analysing their responses to an online survey item.

Literature Review

'*Success'* can be represented differently or take on multiple meanings, applications, and manifestations. Conceptions of '*success'* have been tied to students' cognitive development (Callingham et al., 2017; Maxwell, 2009; York et al., 2015) and described as synonymous and interchangeable with terms like 'academic success', 'academic achievement', and 'student outcomes' (May, 1923; York et al., 2015). These conceptions of '*success'* seem to be frequently tethered to direct or explicit instruction and students' ability to replicate procedures in pre-determined ways (Doabler & Fien, 2013; Shepard, 2000). '*Success'* also pivots around the readiness and ability to transition to the next level of schooling and/or advance to occupation opportunities (May, 1923; Peteros et al., 2019; York et al., 2015). Thus, procedures for ranking students by level of academic achievement at the end of secondary school can accompany the other conceptions of '*success'*.

According to literature sources across one hundred years (e.g., Maxwell, 2009; May, 1923), '*success'* can be evidenced through certain grading and report card practices. However, others (e.g., Clarke, 1997) contend that report card grades are inadequate for representing '*success'*, as grading conveys simplified interpretations of learning as either '*success'* or lack of '*success'*. Notions of '*success'* can be seen in discussions of standardised assessment (Klenowski &

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Wyatt-Smith, 2012; Reid, 2019), such as the Programme for International Student Assessment (PISA), often seen as an indicator of the quality of a country's education system (Reid, 2019), and the National Assessment Program – Literacy and Numeracy (NAPLAN) which "helps schools identify successful programs and identify areas in need of improvement" (ACARA, 2010, p. 7).

Other literature suggests '*success'* in learning mathematics is realised when students undertake a task with multiple possibilities and enact forms of critical thinking, creativity, problem-solving and self-efficacy in sharing their understandings and pathways to reach solutions (Clarke, 1997; York et al., 2015). Watt (2005) writes that "rather than someone who is able to neatly replicate a learned procedure to a routine task in a familiar context, a successful mathematics student has been reconceptualised as one who is able to devise problem-solving strategies" (p. 22), including how this problem-solving involves the identification and application of relevant strategies or procedures in different situations (Clarke, 1997). Some researchers suggest '*success'* transpires when students actively navigate mathematics together and engage collaboratively, such as through real-world applications and social-cultural scenarios reflected in society (e.g., Bada & Olusegun, 2015; Watt, 2005). Conceptions of '*success'* are also connected with emotions and affective domains. Grootenboer and Marshman (2016) write that studies have shown that self-belief or confidence has been a determining factor and predictor of "success in mathematics" (p. 25).

With so much meaning and yet so many contradictions embedded within one single word, there is much value in unpacking and exploring the nuances of '*success'*. Drawing on survey data from our larger research project, the research question addressed in this paper is: "What are teachers' conceptions of the term '*success'* in the mathematics classroom?"

Methodology

This phase of the research project aimed to gather a broad range of experiences and understandings of '*success'*, collected via an online survey (*Qualtrics*) consisting of short responses and Likert Scale questions. There were 139 complete or near-complete responses from teachers of mathematics currently working in Australian schools. They included 37 primary teachers, 56 mathematics-trained secondary teachers, 21 Heads of Departments or Heads of Faculty, 10 out-of-field secondary mathematics teachers, 4 Numeracy Leaders or Numeracy Coaches, and 11 participants who responded with other school-based roles. Participants' teaching year levels ranged from Early Years (Prep-Year 2) to Senior Secondary (Years 10-12), with teaching experience varying from less than 1 year to more than 21 years.

With regard to school demographics, 84 participants were from government schools, 33 from Catholic schools, and 22 from independent schools. The geographical location of the participants' schools was also varied: 57 participants were from major cities, 67 from regional cities and 15 from remote areas. Every State and Territory was represented: Queensland (70), Australian Capital Territory (6), New South Wales (27), Victoria (24), Western Australia (5), Tasmania (3), South Australia (3), and the Northern Territory (1).

A flyer and online survey link were shared informally through social media (e.g., LinkedIn and Facebook), emails, and via several teacher-based social media pages and various national, state or territory-based mathematics teacher associations. There was also a one-page advertisement in a teacher-based magazine, *Prime Number* (edition 02/24), distributed quarterly by the *Mathematics Association of Victoria.*

This paper analyses responses to one survey question: *What is another one-word or simple phrase to describe <u>success</u> in the mathematics classroom?* The analysis started by using an inductive coding approach, allowing categories to be developed from the data. However, it soon became apparent that responses tended to align with the *Australian Curriculum: Mathematics* (v8.4) proficiency strands, prompting a shift to a deductive coding approach. While descriptions for these proficiency strands of *Understanding, Fluency, Problem-Solving* and *Reasoning* do not explicitly use the term '*success*', they do mirror various conceptions of *'success'* previously discussed (ACARA, n.d.a). Nevertheless, the proficiency strand descriptions in the *Australian Curriculum: Mathematics* did not provide adequate clarity to allow coding of participants' responses with confidence. For this reason, further clarification of the meaning of mathematical proficiency was sought from Kilpatrick et al. (2001), which informed the development of the Australian Curriculum's four proficiency strands.

Kilpatrick et al. (2001) identified five interwoven strands of mathematical proficiency: *Conceptual Understanding, Procedural Fluency, Strategic Competence, Adaptive Reasoning* and *Productive Dispositions*, the first four of which broadly correspond to the Australian Curriculum proficiency strands of *Understanding, Fluency, Problem-Solving* and *Reasoning*. Kilpatrick et al. also affirm that proficiency is not an "all or nothing" concept, instead developing over time. Providing greater detail, consistency, and nuance than the descriptions offered by the Australian Curriculum, Kilpatrick et al. gave the following definitions of each proficiency strand, which supported the analysis of teachers' responses to the survey question.

Conceptual Understanding is the "comprehension of mathematical concepts, operations and relations" (Kilpatrick et al., 2001, p. 116). Seen as the "core knowledge of mathematics" (p. 10), *Conceptual Understanding* is more than isolated facts and methods, but the "integrated and functional grasp of mathematical ideas", whereby students "understand why a mathematical idea is important and the kinds of contexts in which it is useful" (Kilpatrick et al., p.118). This proficiency strand is associated with knowledge organisation, making connections between ideas, verbalising connections, and the ability to "represent mathematical situations in different ways and knowing how direct representations can be useful for different purposes" (p. 119).

Procedural Fluency refers to "knowledge of procedures, knowledge of when and how to use them appropriately, and skill in performing them flexibly, accurately, and efficiently" (Kilpatrick et al., 2001, p. 121). *Procedural Fluency* is sometimes confused with applying standard algorithms correctly and quickly; however, much more is involved. *Procedural Fluency* supports carrying out procedures flexibly, accurately, efficiently, and appropriately (Kilpatrick et al.). This proficiency strand is associated with fluency, knowledge, and ways of estimating results procedures, providing tools for computing, and supporting conceptual understanding through the continuing "analysis of similarities and differences between methods of calculating" (p.121). Kilpatrick et al. write how "students can gain insight into the fact that mathematics is well-structured (highly organised, filled with patterns, predictable) and that a carefully developed procedure can be a powerful tool for completing routine tasks" (p. 121).

Strategic Competence refers to "the ability to formulate mathematical problems, represent them and solve them" (Kilpatrick et al., 2001, p. 124) and is similar to what others – including the Australian Curriculum – label as problem-solving and problem formulation (p. 124). Kilpatrick et al. explain how *Strategic Competence* also includes non-routine problems, which "require productive thinking because the learner needs to invent a way to understand and solve the problem" (p. 126) in the classroom and outside of school. This proficiency strand is associated with effective planning to solve problems and forming mental representations, including building "a mental image" of the essential components to solve a problem (p. 124).

Adaptive Reasoning refers to "the capacity to think logically about the relationships among concepts and situations" and the "careful consideration of alternatives", including the "knowledge of how to justify the conclusions" (Kilpatrick et al., 2001, p. 129) and the "determining the legitimacy of a proposed strategy" (p. 131). Interacting with problem-solving, *Adaptive Reasoning* is the capacity for logical thought, reflection, explanation, and justification.

This proficiency strand is associated with intuitiveness, deductive reasoning and inductive reasoning based on pattern, analogy, and metaphor (Kilpatrick et al.).

Productive Disposition refers to "the tendency to see sense in mathematics, to perceive it as both useful and worthwhile, to believe that steady effort in learning mathematics pays off, and to see oneself as an effective learner and doer of mathematics" (Kilpatrick et al., 2001, p. 131). In addition to and developing alongside the other strands, students "must believe that mathematics is understandable, not arbitrary; that, with diligent effort, it can be learned and used; and that they are capable of figuring it out" (p. 131).

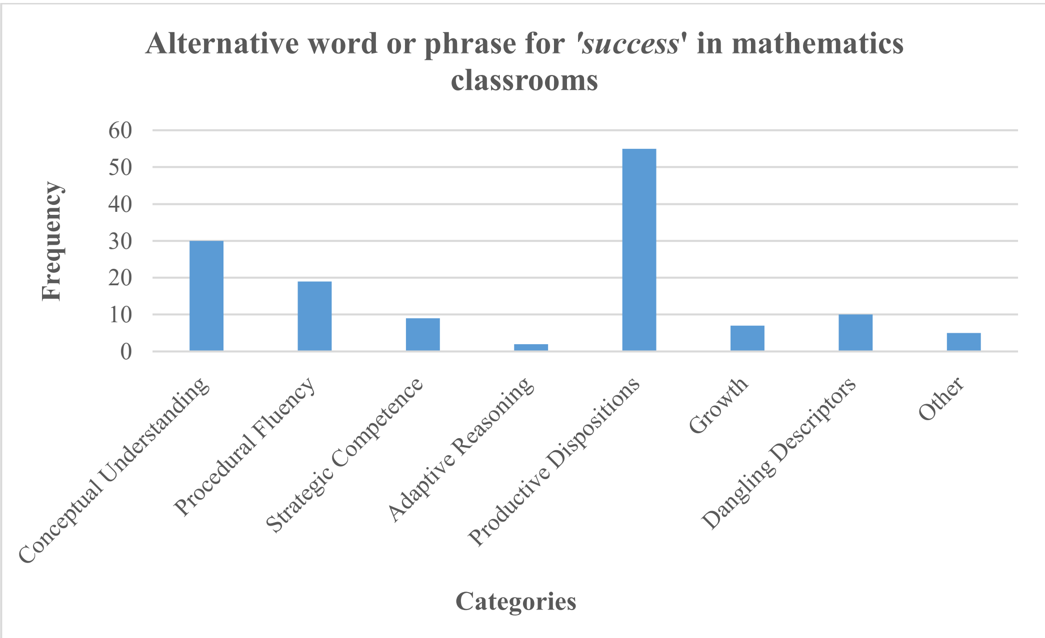
These five categories, corresponding to the five strands of mathematical proficiency, were used to code survey participants' responses to the item asking for an alternative word or phrase to describe '*success*' in the mathematics classroom. There were 137 responses. Each participant's response was assigned one code. In rare cases where participants entered two words of varying potential themes (n=2), separated by either "and" or "/", only the first word was considered to align with the survey question's intent. Altogether, 115 responses could be coded using one of the five proficiency strand categories; inductive analysis of the remaining responses created three additional categories (*Growth*, *Dangling Descriptors*, and *Other*).

Findings

To answer our research question, response frequencies and proportions (percentage of the whole sample) for each category were recorded and are represented graphically in Figure 1.

Figure 1

The Frequency of Each Category of an Alternative Word or Phrase for 'Success'



Productive Dispositions as an Alternative Word or Phrase for '*Success*'

Productive Disposition was the most prominent category of responses (n=55), accounting for 40.1% of survey participant responses. Within this category, roughly one-third of responses (n=19) explicitly state '*confident*' or '*confidence*' as an alternative word for '*success*'. This is also the most commonly stated word or phrase across all responses to this survey question.

Reference to a '*disposition*' was explicitly stated twice. Other alternative words or phrases refer to loving or enjoying mathematics, such as '*love maths*', '*to genuinely love it*', '*enjoying it all*', '*enjoyment*' and '*joy*'. Some alternative words or phrases refer to '*resilience*' or '*perseverance*', with several explicit mentions of these terms, as well as other responses like '*never give up*', '*drive to have a go*' and '*grit*'. Other alternative words or phrases responses associate a specific mindset to approaching mathematics (e.g., '*growth mindset*' and '*Can't do it YET*') or a self-belief towards mathematics (e.g., '*empowerment*' and '*I can. I will try.*'). A curiosity towards mathematics was another concept represented in the alternative words or phrases, such as '*curious connections*' and '*following curiosity*'. Many of these alternative words or phrases for '*success*' can be seen within the descriptions of *Productive Dispositions* provided by Kilpatrick et al. (2001).

***Conceptual Understanding* as an Alternative Word or Phrase for '*Success*'**

Conceptual Understanding was the second most prominent category of responses (n=30), accounting for 21.9% of survey participant responses. Within this category, the word '*Understanding*' (or a variation of it) was the second most frequent term (n=13) across all responses to this survey question. Other alternative word or phrase responses related to connection or being interconnected, for example, '*connections*', '*making connections*', and '*applying connections*'. There are also alternative word or phrase responses that allude to '*solving problems*' and to '*know the strategies*'. Supported by data analysis within the broader research project, a distinction was made between '*solving problems*' as applying known procedures and problem-solving, which emphasises navigating unfamiliar challenges. The latter will be discussed in *Strategic Competence*.

Conceptual Understanding can also be conveyed by personal affirmations of understanding. Teachers offered words or phrases of this type that are identifiable by the use of punctuation marks to portray excitement, notably an exclamation mark (!), as well as the use of first-person language (e.g., "I"). The use of "I" in these remarks is interpreted as that of students, as opposed to teachers, who were the research participants. Together, this subset of responses is referred to as students' affirmations of understanding that share similar sentiments with other words or phrases in the *Conceptual Understanding* category, such as "*the aha moment*", "*epiphany*", and "*enlightenment*". This category suggests that *'success'* can be found in conceptual understanding.

***Procedural Fluency* as an Alternative Word or Phrase for '*Success*'**

Procedural Fluency was the third most prominent category of responses (n=19), accounting for 13.9% of survey participant responses. This includes a few direct references to '*fluency*'. There was also explicit mention of '*flexibility*' within this response category. Other alternative words or phrases refer to the structure of mathematics, such as '*order and patterns*' and '*way of thinking*'. The remaining responses within the category were quite varied expressions of *Procedural Fluency*, for example, '*most efficient*', '*search for solutions*, '*familiarity', skill acquisition*', '*mastery*' and '*clarity*'.

***Strategic Competence* as an Alternative Word or Phrase for '*Success*'**

Although *Strategic Competence* was not the next most prominent response category, continuing to focus on proficiency strands supports a natural progression among related categories. The alternative word or phrase responses (n=9) categorised under *Strategic Competence* primarily focus on problem-solving and application, accounting for 6.6% of survey participant responses. For example, '*problem solver*' was explicitly mentioned three times together with variations on application, like '*applying strategies*', '*applying skills widely*' and '*apply to real life*'.

Adaptive Reasoning* as an Alternative Word or Phrase for '*Success'

The remaining proficiency strand, *Adaptive Reasoning*, was the least prominent category, with only two alternative words or phrase responses: '*reasoning'* and '*analytical'*. This accounted for 1.5% of survey participant responses.

In total, 81.8% of survey participant responses were sorted into the five proficiency strand categories defined by Kilpatrick et al. (2001). A further three minor categories were established, some related to '*success'* in mathematics education more than others. These additional categories are *Growth*, *Dangling Descriptors*, and *Other*.

Growth* as an Alternative Word or Phrase for '*Success'

Seven responses, accounting for 5.1% of survey participant responses, referred to '*growth'* or '*growing'* as alternative words or phrases for '*success*'. Two other responses include '*progress'* and '*improving in maths*'.

Dangling Descriptors

The name of this category plays on the grammar term 'Dangling Modifiers', whereby a word or phrase is not clearly associated with a subject or noun, resulting in ambiguity or confusion for the reader. *Dangling Descriptors* (n=10) accounted for 7.3% of survey participant responses, with alternative words or phrases often describing a '*capability'*, '*proficiency'*, or '*achievement'* but lacking context regarding what or the subject these descriptors are referring to. For example, the *Dangling Descriptor* does not provide information about what the student is 'capable' of or in. A student could be '*capable'* of '*applying strategies'* (a response within *Conceptual Understanding*) and is '*achieving'* through the '*enjoyment'* (a response within *Productive Dispositions*) of mathematics, both requiring further clarification offered in other categories. These ambiguous *Dangling Descriptors* introduce uncertainty, offering limited insight into interpretations of '*success'*, which was the aim of this survey question. As a result, although a category of survey responses, they do not serve as synonyms or alternatives for '*success'* itself.

Other* Alternative Words or Phrases for '*Success'

The category of *Other* (n=5), accounting for 3.6% of survey participant responses, captures two distinct and meaningful subsets of responses that offer an alternative word or phrase for '*success*'. The first subset of responses does not align with the question posed: '*evidence-based'*, '*assessment'* and '*engaged in learning'*. These alternative words or phrases may refer to what participants might think leads to or contributes to '*success',* but do not answer the question. For example, it is unclear if the participant states that the concept of 'assessment' <u>is</u> '*success*' or if they are implying 'assessment' is <u>how they determine</u> '*success'*. The former is an unclear response, while the latter does not answer the survey question that was posed.

The second subset of *Other* includes two unclear yet intriguing responses: '*?*' and '*Depends*.' For the response of '*?*', the participant may not have understood the question, or the response of '*?*' could denote that there is no immediate alternative word or phrase for '*success'*, possibly expressing its uniqueness or that '*success'* encapsulates many conceptions that other terms cannot easily replace. Regardless, the response of '*?*' should not be merely disregarded but taken seriously, despite being categorised as *Other*.

Another participant responded, '*Depends*.' as an alternative word or phrase for '*success'* in the mathematics classroom. This response indicates that '*success'* might be contingent on varying factors or context. Looking at the other responses to this survey question, these varying factors could possibly depend on beliefs, values, perceptions of mathematics, context, interpretations, students, and pedagogical or ideological standpoints. Also worth noting is that very few responses to this survey question included a period or punctuation in their response. If so, punctuation was included after a short phrase. '*Depends*.' was the only single-word response with a period (punctuation). This could be unintentional. Alternatively, it could be very intentional and convey a tone, emphasis, or finality to the statement. This single alternative word suggests there are broader things to consider when substituting for the word '*success*' and, consequently, interrogating the meaning of '*success*' in mathematics education.

Discussion

Analysis of teachers' responses to one survey question suggests that '*success'* in mathematics education may be represented in various ways, but is most predominantly viewed as a *Productive Disposition* within a broader superset of having mathematical proficiency. This is particularly noteworthy because, while the *Australian Curriculum: Mathematics* drew upon Kilpatrick et al. (2001), the strand of *Productive Dispositions* was entirely omitted. Yet, in the absence of a direct prompt within the official curriculum, perceptions of an alternative word or phrase for '*success'* in mathematics education held by Australian teachers of mathematics align most closely with this overlooked strand. We acknowledge that the *Australian Curriculum: Mathematics* (v9.0) (ACARA, n.d.b) has more detailed explanations of mathematical proficiency than v8.4 for *Understanding*, *Fluency*, *Reasoning,* and *Problem Solving*. The interrelatedness of the proficiency strands is also better recognised in that some strands are explicitly mentioned within the definitions of others. But Version 9 still lacks a *Productive Disposition* strand as the humanistic unifier within mathematical proficiency.

The low levels of association of higher-order thinking skills with '*success'* in the mathematics classroom emerged as a notable concern. For example, while teachers' responses that mentioned problem-solving/er and applying/application may represent the larger essence of *Strategic Competence*, the nuance provided by Kilpatrick et al.'s (2001) description for this strand is not wholly represented. The notions of planning and inventing as a part of problem-solving or using mental imagery denote higher-order thinking strategies for making sense of nonroutine problems, as opposed to simply using a known method to solve a routine problem. We cannot know if this kind of productive thinking is what participants had in mind when they responded to the survey question. But we also note that *Adaptive Reasoning*, which interacts with problem solving, was barely present in teachers' conceptions of '*success*'.

Additionally, while not a new development, the intense focus on measurability and quantification structures to determine learning has been increasingly emphasised in recent years (e.g. Reid, 2019). These ideologies are often attached to notions of objectivity and accountability (Watt, 2005). Through this lens, responses coded as *Productive Dispositions* may be viewed as too subjective or less valuable due to their ambiguity or resistance to quantification. However, in comparison, *Dangling Descriptors* – a term marked by minimal specificity and clarity – are even more indeterminate and ambiguous. Notably absent were any explicit references to scores, ranks, or performance metrics – whether in the context of NAPLAN, tertiary entry ranks, or report card grades. While the single mention of '*assessment'* (in *Other*) may be interpreted in this way, this absence of metrics suggests teachers do not widely perceive such measures as conceptions of '*success'*. This observation raises important questions about their priority and influence in the shaping of mathematics classrooms.

Implications

This paper offers insight into the nature of '*success'* and conceptions of '*success'* in the mathematics classroom, as perceived by teachers. The findings might support the navigation of multiple and often conflicting messages surrounding '*success'*, enabling educators to focus on creating and fostering conditions that align with these identified aspects of '*success'* and reflecting on structures that support progress towards achieving them. The first action towards this goal is to include *Productive Dispositions* in the curriculum with the other four proficiency strands to ensure appropriate emphasis is given to the full conceptualisation of mathematical proficiency within pedagogical practices, strategic planning, and system decision-making. These findings also suggest that, despite an array of descriptions of '*success'* in the literature, mathematics teachers converge on a consistent conception of '*success'* in mathematics education independently of curriculum constraints or governmental mandates. This broader understanding of '*success'* unlocks greater opportunities, ensuring more students can genuinely engage with and experience meaningful '*success'* in mathematics education.

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