# Using the Mathematics Assessment Interview and Growth Points to Identify Grade 1 Students Who Are Not Yet Thriving in Mathematics Midway Through the School Year

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Assessing and monitoring the mathematics progress of students is a key role for teachers. It is important for assessment tools to identify students who are not yet thriving and provide guidance for teachers about how to support these students. In our study, teachers assessed 396 Grade 1 students midway through the school year using the Mathematics Assessment Interview and framework of growth points. The findings describe a wide distribution of knowledge across the growth points in each of the number domains. Further analysis showed that at least 30% of students were vulnerable in each number domains, highlighting the need for mathematics interventions.

Most children thrive with learning mathematics when they transition to school, but not all. Teachers work hard to advance equity and inclusion for students who are not yet thriving and implement various teaching approaches and curricula to assist them. However, these approaches are typically *ad hoc* because Australian primary teachers are generalists who seldom have the opportunity to develop the specialist knowledge associated with diagnosing students' mathematics difficulties, nor designing associated responsive teaching (Gervasoni et al., 2021). It could be argued that initiatives in Australia for supporting students who are not yet thriving in mathematics need to include professional learning to build teachers' expertise.

The research reported in this paper is part of a larger project funded by the NSW Department of Education to advance primary mathematics intervention professional learning, specifically to support students who were mathematically vulnerable. One aspect of the study was providing professional learning about using the Mathematics Assessment Interview (MAI) (Gervasoni et al., 2011) formally known as the Early Numeracy Interview (Clarke et al., 2002; Clarke, 2013) so that classroom teachers could: (1) identify each student's current knowledge across four number domains; (2) use the data to position each student's knowledge along a framework of growth points, and then use this data to guide and differentiate teaching; and (3) identify any students who were mathematically vulnerable. A subsequent aspect of the project involved professional learning for specialist mathematics intervention teachers who would use the MAI data to prioritise students for an intervention program in semester 2, and use the growth point framework to guide their teaching while implementing the intervention. In previous research involving the MAI, students were assessed at the beginning and end of the school year, but never at the midpoint of the year. Because our study began in May, this provided the opportunity to gain new insights about a cohort of Grade 1 students' knowledge midway through the year.

Two research questions frame the findings reported in this paper: (1) What is the growth point distribution for Grade 1 students midway through the school year in four number domains? (2) What proportion of Grade 1 students are mathematically vulnerable in each number domain midway through the school year?

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# Background Literature

The research reported in this paper builds on previous studies that used data from task-based mathematics assessment interviews and learning trajectories to: (1) describe the range of primary students' mathematical knowledge at a point in time; (2) plan responsive teaching; and (3) identify students who were mathematically vulnerable. The following section provides an outline of this literature, with a focus on the assessment interview and growth point framework used in this study.

## Interview-based Mathematics Assessment

One-to-one interview-based mathematics assessment tools that assist teachers to systematically identify each students' current mathematics knowledge along a learning trajectory (Clements et al., 2023) are helpful for supporting teachers' efforts to provide ambitious and equitable mathematics teaching (Cobb et al., 2018). Australasian research over the past 25 years has a rich tradition of developing such tools (Bobis et al., 2005; Clarke, 2013; Wright et al., 2000). Clarke (2013) claims that the experience of task-based, one-to-one assessment interviews makes a major contribution to teachers' understanding of the mathematics, the trajectories, children's minds, the obstacles, and the principles of instruction that Ginsburg (2009) argued informs the teaching of a child or group of children.

### *The Mathematics Assessment Interview and Growth Points*

The Mathematics Assessment Interview (MAI) (Clarke et al., 2002; Gervasoni et al., 2011) is an example of a task-based one-to-one assessment interview with associated research validated growth point framework that describes key stages in students' development. The MAI was an output of the Early Numeracy Research Project (Clarke et al., 2002), and is a key tool used in our study. It requires the teacher to sit with each student, present a series of mathematics tasks that are described in a detailed script, and to observe and probe the student's thinking and strategies for solving mathematics tasks, until they have a deep understanding of the extent of the student's current knowledge. Based on a student's strategies and responses, the assessment script leads students through different tasks in nine mathematics domains, just like a choose your own adventure story. The development and details of the assessment interview, tasks, and growth points are described in full in Clarke et al. (2002).

The principles underlying the construction of the growth points were to: describe the development of mathematical knowledge and understanding in the first three years of school in a form and language that was useful for teachers; reflect the findings of relevant international and local research in mathematics education; reflect, where possible, the structure of mathematics; allow the mathematical knowledge of individuals and groups to be described; and enable a consideration of students who may be mathematically vulnerable (Clarke et al., 2002).

The growth point data generated from the MAI have a broad range of uses for teachers, schools, and systems in responding to students' current mathematical thinking, knowledge, and progress. For example, the MAI can also be used systematically to screen or identify students who are mathematically vulnerable. Also, the teaching advice embedded in the growth point framework for each domain (see Gervasoni, 2015) can assist teachers to focus their teaching in ways that support individual students to advance and accelerate their mathematics learning. Schools can use the assessment data and learning trajectories to identify students who may benefit from additional support, tutoring, or intervention programs.

To explain the nature of the growth points, the following are the growth points for Addition and Subtraction Strategies. These describe the strategies students use to calculate mentally.

1. Counts all to find the total of two collections.
2. Counts on from one number to find the total of two collections.

3. Given subtraction situations, chooses appropriately from strategies including count back, count-down to & count up from.
4. Uses basic strategies for solving addition and subtraction problems (doubles, commutativity, adding 10, tens facts, other known facts).
5. Uses derived strategies for solving addition and subtraction problems (near doubles, adding 9, build to next ten, fact families, intuitive strategies).
6. Extending and applying. Given a range of tasks (including multi-digit numbers), can use basic, derived and intuitive strategies as appropriate.

Each growth point represents substantial growth in knowledge along paths to mathematical understanding. A student's growth point at a given point in time can also be used to identify students who are mathematically vulnerable (Gervasoni et al., 2021).

### *Identifying Students Who Are Mathematically Vulnerable*

There is no universally agreed method for identifying students who are mathematically vulnerable or experience difficulty with mathematics. Typically, teachers or researchers use cut-off scores on tests, proficiency benchmarks, or percentile ranks such as scores below the 10th, 20th or 35th percentiles, to identify students who are not thriving (Powell et al., 2021).

As part of the Early Numeracy Research Project and subsequent research, Gervasoni (2015) used growth points generated from the MAI to identify students who were mathematically vulnerable and may benefit from intervention. Growth points in the Counting, Place Value, Addition and Subtraction Strategies, and Multiplication and Division Strategies domains were used for this purpose. Through analysing February MAI data for large cohorts of students, opinions from over 200 teachers, and curriculum expectations, a set of *on the way* growth points were determined for each grade level (see Table 1). The idea is that the *on the way* growth point describes the mathematics knowledge in a domain required for students to fully engage in mathematics lessons and thrive with learning mathematics. Students who have not reached these growth points are likely to be mathematically vulnerable because they are yet to learn the mathematics necessary to fully engage with the curriculum for their class.

**Table 1**

*February-June on the Way Growth Points for Each Grade Level (Gervasoni, 2015, p. 96.)*

| **Number domains** | **February-June *on the way* growth points for each grade level** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **F** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** |
| Counting | [1] | 2 | 3 | 4 | 5 | 5 | 5 | 6 | 6 |
| Place Value | [1] | 1 | 2 | 3 | 3 | 4 | 4 | 5 | 5 |
| Add & Sub | - | 1 | 2 | 3 | 4 | 5 | 5 | 5 | 6 |
| Mult & Div | - | 1 | 2 | 3 | 3 | 4 | 5 | 5 | 6 |

As part of the Extending Mathematical Understanding (EMU) Project in 2018, Gervasoni et al. (2019) used the *on the way* growth points to identify Grade 1 students who were mathematically vulnerable and prioritise them for the EMU intervention program. The MAI was used to assess 3277 Grade 1 students from 57 schools in February. Based on the *on the way* growth points in Table 1, the results suggested that 27% of students were vulnerable in Counting, 10% in Place Value, 14% in Addition and Subtraction, and 24% in Multiplication and Division (Gervasoni et al. 2019). With the exception of the Counting results, these proportions were similar to those reported in the Early Numeracy Research Project involving 1497 Grade 1 students (Gervasoni, 2015). In the latter case, only 11% of students were vulnerable in Counting. However, it is not known what proportion of students are vulnerable midway through the school year, as the MAI was used only at the beginning or end of the school

year in the two studies described earlier. It would be useful to establish whether the proportion of students who are vulnerable reduces or increases as the school year progresses, so that teaching and interventions could be more targeted if needed.

A set of *on the way* growth points were also developed to assist teachers prioritise students for interventions in the second semester of the school year. These are described in Table 2.

**Table 2**

*July-December on the Way Growth Points for Each Grade Level (Gervasoni, 2015, p. 96)*

| Number domains | July-December o*n the way* growth points for each grade level | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **F** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** |
| Counting | [2] | 3 | 4 | 5 | 5 | 5 | 6 | 6 | 6 |
| Place Value | [1] | 2 | 3 | 3 | 4 | 4 | 5 | 5 | 5 |
| Add & Sub | [1] | 2 | 3 | 4 | 5 | 5 | 5 | 6 | 6 |
| Mult & Div | [1] | 2 | 2 | 3 | 4 | 5 | 5 | 6 | 7 |

Overall, the MAI and growth point framework provide a criterion-based method for identifying students who are mathematically vulnerable. This process draws on the distribution of MAI growth points for large cohorts of Australian students, and the expectations of teachers and curriculum documents about the level of mathematics necessary for students to fully engage with mathematics learning in their class. New insights to inform interventions are needed about the proportion of students who are mathematically vulnerable midway through the school year.

## Method

The research reported in this paper drew on quantitative methods to address the research questions. The data collected for analysis was derived from the Mathematics Assessment Interview (MAI), described earlier. The Early Numeracy Research Project growth points (Clarke et al., 2002; Gervasoni et al., 20111) were used as a framework to describe the distribution of student's knowledge in each of four number domains. The Extending Mathematical Understanding *on the way* growth points (see Table 1 and Table 2) were used to identify students who were mathematically vulnerable.

MAI growth point data was collected in 2024 for 396 Grade 1 students from 15 NSW primary schools from metropolitan, regional, and rural locations. The students were assessed midway through the school year (June/July) by their classroom teachers. The teachers participated in a professional learning day via zoom to learn about the assessment interview, and how to use the tool to assess students and analyse the data to determine students' growth points in the four number domains. The professional learning included the opportunity for teachers to assess a student, and then to clarify any questions about the assessment process and method for analysing the data to determine growth points. The MAI includes a detailed assessment script for teachers to follow, a detailed assessment record sheet for recording student responses, and a scoring rubric for analysing the assessment data to determine growth points. Teachers in each school moderated the process for assigning growth points to further the trustworthiness of the findings. Any discrepancies were discussed until agreement was achieved, or were referred to the research team for clarification.

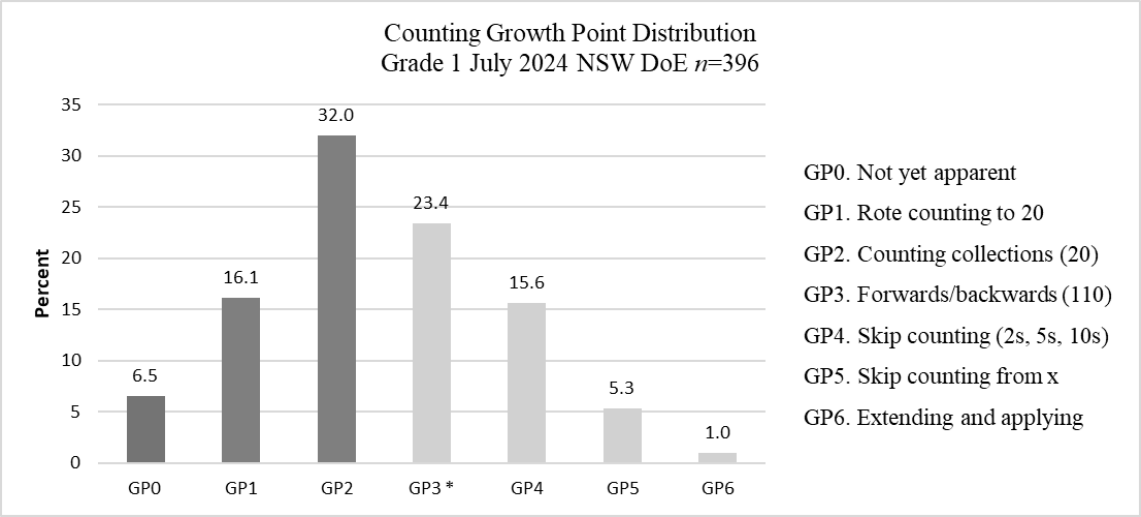
The growth points for each student were entered into an excel spreadsheet by the teacher, submitted to the education system for collation and de-identification according to approved ethical guidelines, and then submitted to the research team for analysis. Teachers used the students' growth points to plan subsequent teaching and for curriculum planning to respond to students' diverse knowledge, and to identify students who were mathematically vulnerable and who may benefit from the intervention program being implemented as part of the project.

## Results

Results for this study provide insight about (1) the growth point distributions for Grade 1 students midway through the school year in four number domains, and (2) the proportion of Grade 1 students who were mathematically vulnerable in each number domain midway through the school year. Figures 1-4 show the growth point distributions for the students in Counting, Place Value, Addition and Subtraction Strategies, and Multiplication and Division Strategies. The growth point with an asterix in each figure represents the *on the way* growth point midway through the school year (e.g., GP3* in Figure 1). The proportion of students who have not reached the *on the way* growth point is represented in the darker grey columns in each figure. These columns represent students who were identified as mathematically vulnerable.

**Figure 1**

*Counting Growth Point Distributions for Grade 1 Students in July 2024*




The results in Figure 1 show the wide spread of knowledge and progress in Counting for this group of 396 students. The first finding to emerge is the wide spread of knowledge across all Counting growth points (GP), including that 75% of students are spread across four growth points from *rote counting to 20* (GP1) to *skip-counting by 2s, 5s, and 10s from 0* (GP4). Second is the large proportion of students who cannot yet *count forwards and backwards by ones beyond 110* (GP3, 54.6%) which is the screening growth point for identifying students who are vulnerable in Counting midway through Grade 1. Third is the proportion of students who cannot yet *count a collection of 20 objects* (GP2, 22.6%) which is also the screening growth point for identifying students who are vulnerable in counting in February. Fourth is that 6.3% of students had reached the two highest growth points (GP5 and GP6). These latter growth points involve students demonstrating early algebraic thinking and applying counting knowledge to solve problems. Overall, the findings suggest that although curriculum and teaching enable some Grade 1 students' counting to advance to the highest growth points by the midpoint of the school year, there remains a large proportion of students who are struggling to progress.

The results in Figures 2-4 follow a similar pattern to those for the Counting domain. For Place Value (Figure 2) there is also a wide spread of knowledge for the 396 students. Nonetheless, 86.9% of the students are concentrated across *reading, writing, ordering, and interpreting 1-digit numbers* (GP1) and *2-digit numbers* (GP2). More than half of the students did not yet understand 2-digit numbers, the screening growth point midway through Grade 1. Also, 7.3% of students did not yet understand 1-digit numbers, which is also the screening growth point for students at the beginning of Grade 1. A small proportion of students reached the highest growth points in Place Value. These students could interpret 4-digit numbers and greater, and apply their knowledge to solve complex problems.

**Figure 2**

*Place Value Growth Point Distributions for Grade 1 Students in July 2024*

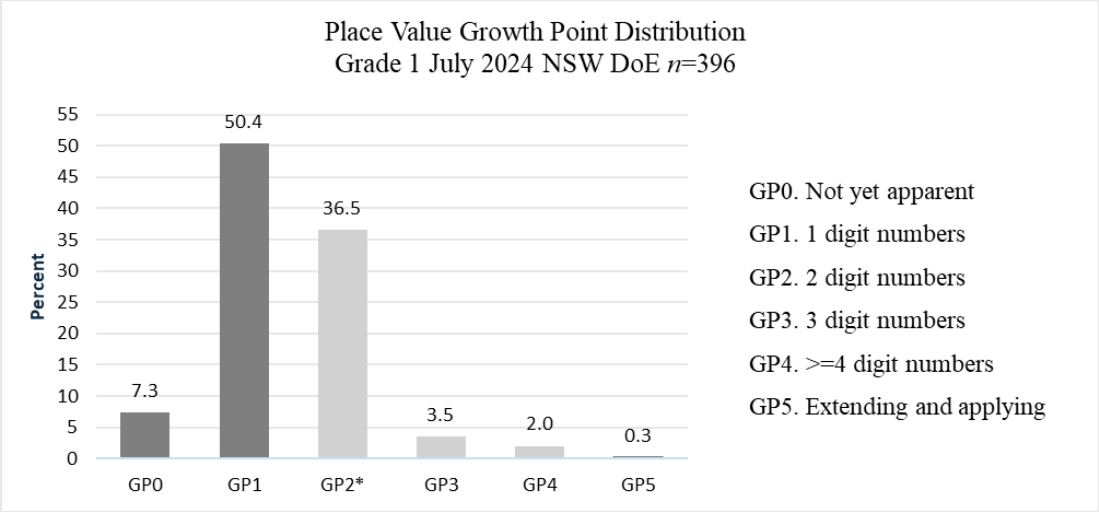



**Figure 3**

*Addition and Subtraction Strategies Growth Point Distributions for Grade 1 Students in July 2024*

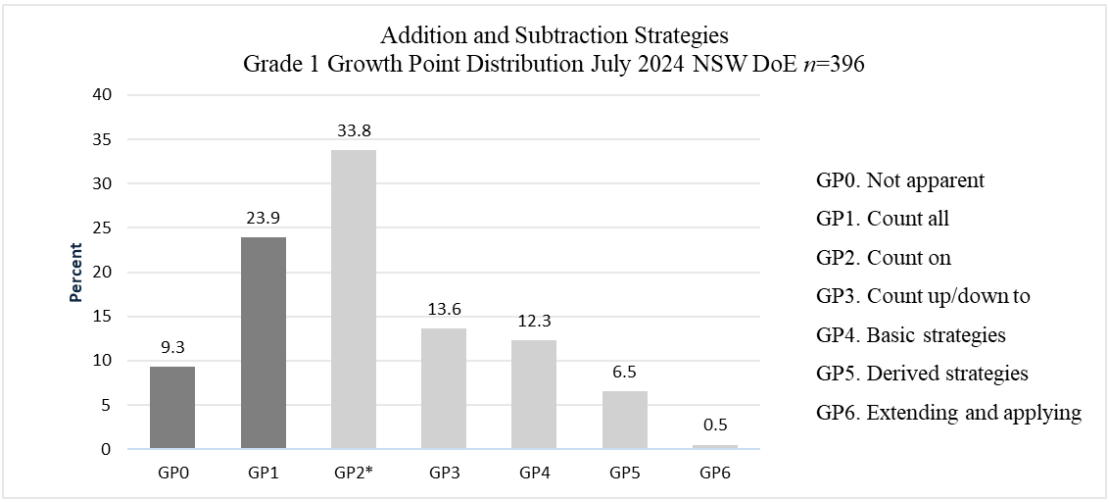
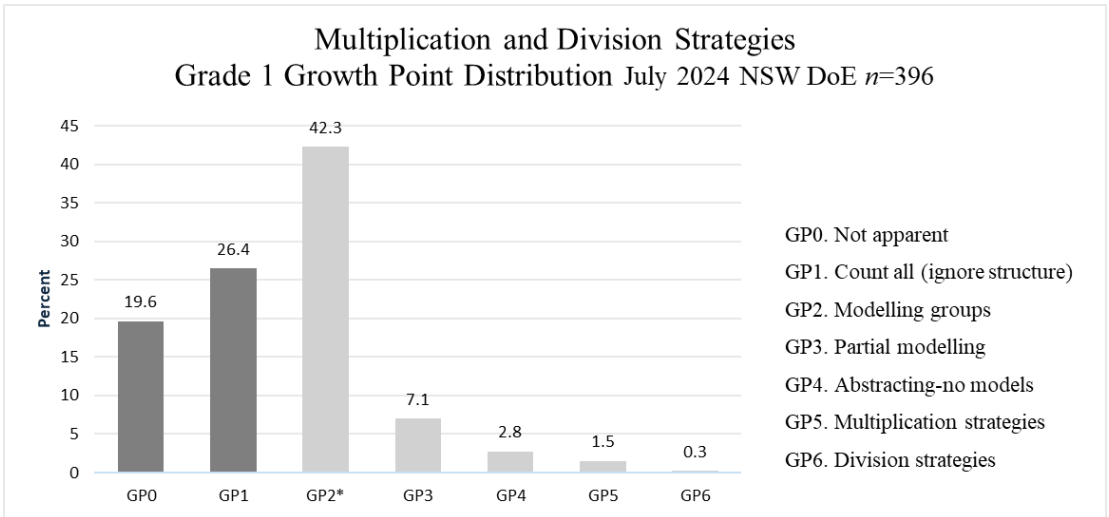



**Figure 4**

*Multiplication and Division Growth Point Distributions for Grade 1 Students in July 2024*



The results for Addition and Subtraction Strategies (Figure 3) also show a wide distribution across all growth points, with about 80% of students spread from *counting all* (GP1) to *using derived strategies* (GP5) to perform mental calculations. Most students (78.3%) used counting strategies to calculate (GP1-GP3). There were 33.2% not yet counting-on to calculate the total of 9+4 objects (with 9 objects hidden), the screening growth point midway through Grade 1. Also, 19.3% of students were on GP0 and not yet able to solve 9+4 represented with visible objects (GP1), the screening growth point at the beginning of Grade 1. Almost 20% of the students were using basic strategies (GP4) and derived strategies (GP5) to calculate mentally.

Similarly, the results in Figure 4 for Multiplication and Division Strategies show a wide distribution across all growth points, with 88.3% of students spread from GP0 to GP2 *using the multiplicative structure to calculate in situations that are modelled*. The screening growth point for students midway through Grade 1 is GP2, and 46% of students had not yet reached this growth point. It is notable that 19.6% of students, midway through the year, were not yet able to solve multiplicative problems that were modelled with objects *through counting by ones* (GP1). This is the screening growth point at the beginning of Grade 1. More than half of the students (54%) recognised and used the multiplicative structure of a situation to solve problems, and approximately 10% of students could do so in partially modelled situations (GP3+), or abstractly without models (GP4+).

## Discussion

The wide distribution of Grade 1 students' number knowledge at the beginning of the year has been reported previously (Clarke et al., 2002; Gervasoni et al., 2019). The findings for this study extend this previous work to show that a wide spread of knowledge for each number domain was also apparent midway through Grade 1 for the 396 participating students. Such diverse knowledge in each of the four number domains of the MAI highlights the complexity of classroom teaching, and emphasises the need for assessment tools that can be used to identify students' current knowledge along a learning trajectory so that teachers can design targeted differentiated teaching that can advance every student's learning. It is useful for learning trajectories to include teaching advice and exemplar tasks that can guide teachers.

The findings also demonstrate that in every number domain and midway through Grade 1, at least 30% of students in the study were mathematically vulnerable with respect to the *on the way* screening growth points. It is likely that many of these students were vulnerable in multiple domains, an issue that would be useful to investigate through further analysis of these data. When comparing the proportion of Grade 1 students who were vulnerable midway through the school year with previous findings reporting the proportion who were vulnerable at the start of the year, (Gervasoni, 2015; Gervasoni et al., 2019) the proportions were much larger midway through the year. Although these comparisons represent different cohorts, the implication that the proportion of students who are vulnerable increases across Grade 1 is worthy of further research. Given that the students in this study had been at school for 18 months, it is likely that some would benefit from additional support or intervention programs earlier than midway through Grade 1. Further, without additional targeted support, these students may remain mathematically vulnerable. It is likely that early primary teachers may benefit from professional learning that assists them to understand the nature of mathematics learning associated with the first three growth points in each number domain. This additional expertise may assist teachers to design curriculum and teaching to accelerate learning for students who are not yet thriving.

## Conclusion

Midway through the school year, the Grade 1 students in this study exhibited a range of knowledge in each domain that extended from the lowest to highest growth points. This finding suggests that the curriculum and teaching offered in the first semester of Grade 1 was

sufficiently challenging to enable students to extend their learning. Conversely, the fact that so many students at the midway point of the school year were struggling to progress in each of the four number domains suggests that the Grade 1 curriculum and teaching needs to be more focused to assist students who are mathematically vulnerable. It is notable that, half way through the school year, at least one third of the Grade 1 students had difficulty with counting beyond 110, interpreting 2-digit numbers, using non-counting-based strategies to mentally add and subtract, or using the multiplicative structure to calculate when a situation was modelled. It is likely that more specialised teaching of these aspects of number learning is needed to ensure that all young students flourish. Given the importance of mathematics in further education, employment and life, this situation warrants the attention of school leaders, policy makers, professional learning developers, and researchers.

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