Primary Mathematics Curriculum Consultation: Consultation with Children

FINAL REPORT

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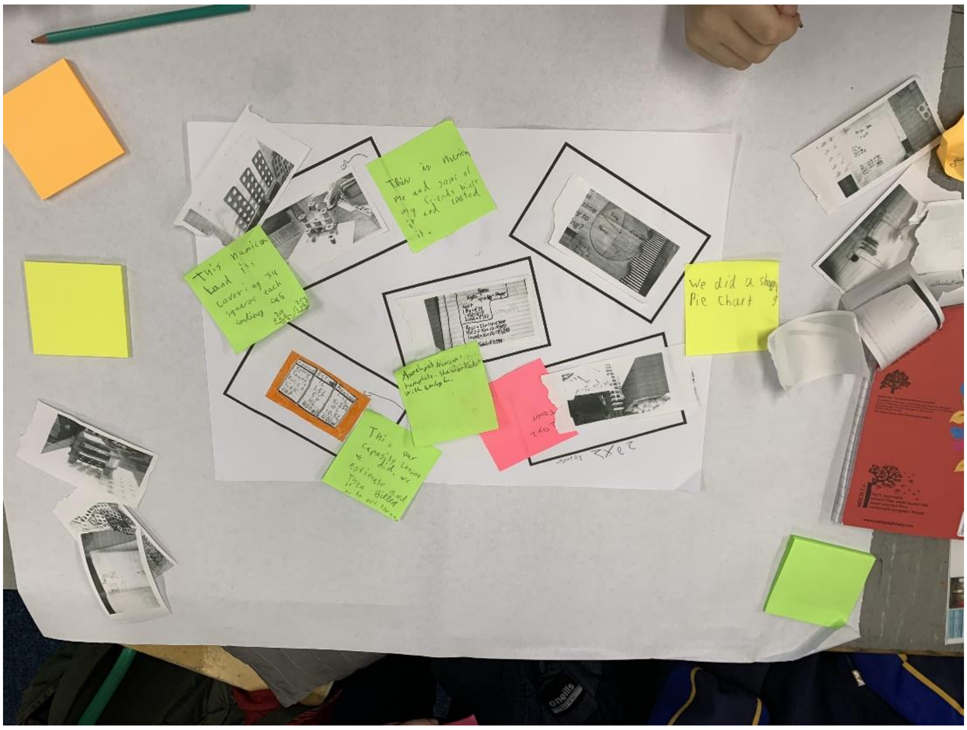

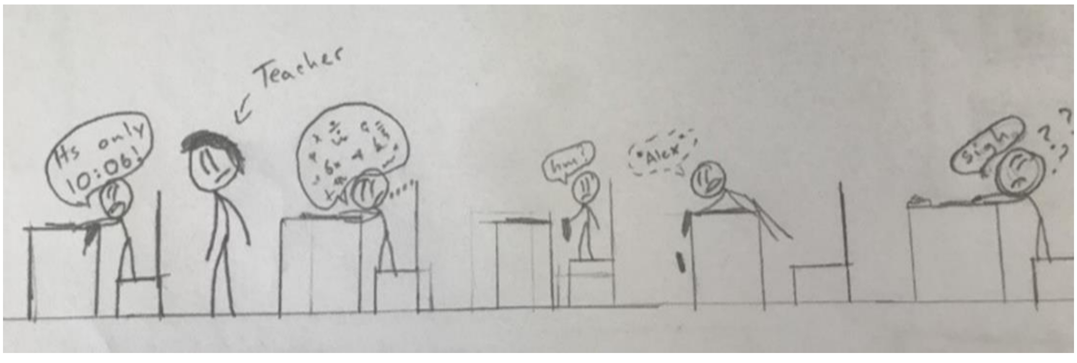

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1.0 Executive summary

For almost a decade, the National Council for Curriculum and Assessment (NCCA) has been preparing for curricular reform of primary mathematics. A series of research reports (Dooley *et al*., 2014; Dunphy *et al*., 2014) and background papers and briefs (NCCA, 2016) have informed and shaped curriculum development. The first stage of the curriculum development process was initiated by the publication of the draft new curriculum for junior infants to second class which was sent for consultation with teachers, parents, children and other stakeholders (NCCA, 2017). Attention then turned to the senior classes of the primary school with the publication of a series of research addenda (Dooley, 2019) and short research papers (Delaney, 2020; Leavy, 2020; Nic Mhuirí, 2020a, 2020b; Twohill, 2020) on teaching and learning mathematics in the senior classes primary school. A four-strand consultation on the *Draft Primary Mathematics Curriculum (PMC)* was undertaken in the first half of 2022 to gather feedback from educators, parents and guardians, school networks and children. This document reports on the outcomes of the consultation with children.

The objective of this research was to gain insights into children's experiences of primary mathematics. Lundy's rights-based Model of Participation (2007) was used to guide and structure the design of participatory methodologies for use with children. Ethics clearance was provided by Mary Immaculate Research Ethics Committee (MIREC) and all information, consent and assent forms sent to the twelve classrooms who volunteered to participate in the research study. Each classroom was visited twice. During the first visit, children were introduced to a member of the research team, the study was described and child-friendly instant cameras were distributed. During the second visit, approximately one month later, the researcher returned to the school with a second researcher and worked with children to gain insights into their experiences of mathematics. Researchers used a toolbox of five child participatory strategies to give voice to children's experiences: (1) Photovoice, (2) Draw and Tell, (3) Student as Journalist (including Vox Pop) (4) Strand Ranking Activity, and (5) Focus Group Interviews.

Following extensive analysis of the data corpus, using grounded theory methods, seven themes emerged.

Theme 1: Children's experiences of collaboration and communication in mathematics

Theme 2: Children's perspectives on teacher roles in the mathematics classroom

Theme 3: Children's experiences of mathematics
Theme 4: Children's experiences of mathematics textbooks
Theme 5: Children's experiences of context in mathematics
Theme 6: Children's experiences of challenge in mathematics
Theme 7: Children's experiences of assessment

With regard to *children's experiences of collaboration and communication when doing mathematics* (Theme 1), working with others was referenced by all but one class. Children in the remaining nine classes reported engaging in some form of group work. Across all ten classes, children referred to the social element of group work, the opportunity to work with your friends and the enjoyment associated with collaboration. Regardless of experiences, children expressed a desire for more collaboration. Talking and communicating was viewed as an integral element of group work. Consequently, classes that reported little or no groupwork placed less emphasis on the role of discourse in mathematics. In contrast, many children across four classes specifically referred to the importance of communication in mathematics. For one class, children reported on the centrality of 'maths talk' to their mathematics learning, supporting them to develop conceptual understanding and to solve cognitively challenging activities. Irrespective of the extent of their experiences of communication in mathematics class, all children readily identified its potential benefits and their desire to engage in more.

The consultation also uncovered *children's perspectives on teacher roles in the mathematics class* (Theme 2). In many classes, the teacher was depicted as a central figure. For example, many children viewed the teacher as 'explainer'. Some children identified the teacher's role as that of 'helper' during times when they required assistance. While descriptions of teacher as 'explainer' and 'helper' were dominant, children in classes that reported engaging in more group work and communication made very little reference to their teacher or the role of the teacher. In these contexts, the teacher's role was de-emphasised, and references to them suggested the teacher as 'facilitator.

Children's experiences of mathematics (Theme 3) varied. Children who reported a predominantly procedure-focused learning experience generally communicated negative emotions in response to their mathematics experiences. In some of these classes, children viewed getting the 'right answer' as important in mathematics, and in some instances, the sole goal in mathematics. Equally, in some of these classes, children identified 'speed' as being valued and rewarded in mathematics. In contrast, children in some other classes reported positively on regular opportunities to actively engage in meaningful, learner-centred mathematics activities. These included cognitively challenging problem solving and problem posing activities, deeply embedded in rich contexts, with multiple correct solutions. In these classes, children expressed the view that understanding mathematics, and accuracy in mathematics, are more important than speed. Children universally acknowledged favouring more interactive learning opportunities including the use of real world contexts, hands-on experiences and playful mathematical experiences such as maths games. Children in one senior class challenged the perception that reform-based approaches are not relevant for them. They consistently communicated a desire for more variety of engaging learning approaches to promote their interest in and enjoyment of mathematics.

The consultation provided interesting insights into *children's experiences of mathematics textbooks* (Theme 4) with much variation reported in textbook use. Mention of textbooks often triggered emotive responses. Many children's negative reaction was linked to perceptions that textbook activities were monotonous and tedious. In contrast, a few children across classes reported less disdain for the textbook. Some children were extremely critical of the structure of various textbook series, including book length, limited revision opportunities and the quality of explanations. Despite identifying various issues with mathematics textbooks, many children believed it has a place in their learning and acknowledged the affordances of the textbook series they used, recognising its role when revising. However, children highlighted that the textbooks provided limited learning experiences relative to alternative approaches and objected to its excessive use. Children demonstrated a thirst for mathematics experiences beyond the textbook. One class who had not used textbooks during mathematics class during their current school year communicated a preference for this approach, with justifications including a sense of increased flexibility, better quality learning experiences and increased ownership over their learning.

The data analysis also uncovered *children's experiences of context in mathematics* (Theme 5). Many children demonstrated a keen awareness of the role of context in mathematics, drawing from the role of mathematics in their pastimes, everyday experiences and in their future professional lives. In general, they placed high value on mathematics strands that had most real-world relevance for them. In contrast, in several classes, children failed to see the relevance of certain areas of mathematics. This was especially evident with reference to Algebra. This deficiency makes a compelling argument for greater use of contexts when teaching these concepts. There was a strong mandate, evident across classes, for more meaningful and context-driven mathematics to be used in schools. In two classes, children spoke excitedly about contexts used to situate the mathematical learning, demonstrating a keen appreciation for the role of mathematics in everyday life.

When exploring *children's experiences of challenge in mathematics* (Theme 6), it was apparent that many children welcomed challenge in mathematics, recognising the opportunity to learn arising from engaging with challenging activities. For a small number of children, the challenge mathematics provided was the reason they liked mathematics. These children associated challenge with enjoyment and feelings of achievement and success experienced when they completed challenging activities. For the children who had experience of cognitively challenging tasks, they referred to the support provided by working cooperatively with others, sharing solutions and engaging in maths talk. However, children did not want every activity to be challenging and desired challenges that were within their reach. An important caveat for many children centred on knowing when to expect challenging activities. Children appreciated knowing, in advance, whether an activity would be challenging. Conversely, children did not appreciate underchallenging mathematics, referring to the monotony of completing exercises relating to number operations or procedures-focused tasks.

The child consultation revealed some *children's experiences of assessment* (Theme 7). Children in four classes detailed their affective response to mathematics testing, that included confusion, anger, frustration, and pride. In contrast, children reported that tests can reward hard work and provide feedback. Children from one class identified mathematics journals as a useful assessment aid. These children also identified a 'traffic light' system as being a useful self-assessment strategy in mathematics class. Contrastingly, the children in another class reported stand-alone assessments with no opportunities for children to review or consult these tests after they were completed or corrected. Children highlighted the importance of teachers connecting with children's current understanding of mathematics to inform their practice.

2.0 Introduction

The primary remit of this research study was to give voice to children's experiences of primary-level mathematics. The theoretical framework underpinning the approaches used to uncover and communicate children's mathematics experiences situates the child in the centre of all decision making and considerations.

Children are important "expert witnesses" (Lodge 2005, p.129) of classroom events. However, a lack of experience representing their mathematical thoughts can make the mathematical process invisible to children leading to difficulty communicating their mathematical experience (Chapin *et al*., 2003). Consequently, their valuable insider perspectives may be inaccessible to adults (Bland & Atweh, 2004). Moreover, as Parks (2020) highlights, successful efforts accessing children's learning experiences in mathematics depend heavily on verbal interactions and "children who are silent generally do not show up" (p. 1444) resulting in the need for more diverse methodological tools "that open up analyses to data beyond what is said in public spaces" (p. 1480). Furthermore, children's perspectives about learning mathematics can provide unique, context-specific insights which in turn can motivate teachers' engagement in, and commitment to, reform processes (Treacy & Leavy, 2021).

Article 12 of the UN Convention on the Rights of the Child (UNCRC) (United Nations (UN), 1989) provides that children have the right to have their opinions considered, their views respected in decision-making that affects them, and given due weight in accordance with their age and maturity. Prioritising children's participation impacts positively on their self-esteem and confidence; and promotes their overall development, autonomy, independence, social competence and resilience (Harmon, 2021; NCCA, 2020; Ring *et al*., 2018).

Fostering authenticity in child voice research has proved challenging, and in order to prevent tokenistic participation, requires researchers to actively involve children in the research process (Montreuil *et al*., 2021). Such involvement views children as agents rather than objects, and enables children's views to be interpreted through child-centred outlooks, rather than solely through adults' views of their experiences (Montreuil *et al*., 2021). Participatory strategies include *inter alia* hand puppets, 'draw and tell' (Coyne *et al.*, 2021) student drawings and inscriptions (Leavy & Hourigan, 2018a, 2018b, 2021a, 2021b), and letter writing initiatives (Leavy & Hourigan, 2022, 2021c); capacity-building sessions, photography/filming, and group discussions (Montreuil *et al*. 2021); sorting exercises (Foster-Fisherman *et al*., 2010); map creation, sculpting, and producing digital stories (Brown *et al*., 2020); and child-led interviews (Blanchet-Cohen & Di Mambro, 2014).

Homogeneity in child voice research can result in partial, or biased, conclusions in which the voices of children who are more confident, articulate, or successful in school are privileged (Cremin *et al.*, 2011; Flutter, 2007). Whilst seeking out marginalised voices or suppressed voices is challenging (Arnot & Reay, 2007) doing so can lead to a richness of important and serious insights (Fielding, 2004). Utilising participatory visual research, including photographs and drawing, in accessing difficult-to-reach voices has powerful potential with children (Brown *et al.*, 2020).

Building trust with children and placing trust at the heart of child voice initiatives can begin to shift power differentials (Czerniawski, 2012; Ruddock & McIntyre, 2007) and so contribute to more child-centred research. In particular, child-led interviews have been found to decrease this power-differential (Hacking & Barrett, 2009) and to increase child confidence (Blanchet-Cohen & Di Mambro, 2014). Cameras also contribute to a shift in power differentials, in addition to facilitating children's engagement (Montreuil *et al*., 2021).

When working with children, Lundy's rights-based model of child participation ensures that all children's views are valued and respected (Lundy, 2007). It highlights four components that are necessary to ensure that Article 12 of the UNCRC (UN, 1989), is achieved: promoting purposeful engagement with children, challenging tokenism and moving beyond children as objects of research (Harmon, 2020). This model of participation was the framework used to guide, design and structure the methodologies used to work with children and gain access to their experiences as learners of primary mathematics.

3.0 Methodology

This section describes the rationale for the design of the study and details the strategies and research instruments employed. Information in relation to the strategies used and sampling approaches taken are outlined. Child voice was the central focus of this study. The study investigated children's experiences of learning mathematics in third to sixth classes in Irish primary schools.

3.1 Research Design

3.1.1 Grounded Theory

This qualitative research design employed the grounded theory approach. Grounded theory involves constructing inductive theory through theoretical sampling (Glaser & Strauss, 1967), and consequently the primary purpose of grounded theory is the construction of theory from data (Corbin, 2009). Such construction involves inevitable interaction between the researcher and the data, in a manner that is aligned with the "fluid and dynamic nature of qualitative analysis" (Corbin, 2009, p.40). The theory is generated from, and is rooted in, the data (Cohen, Manion & Morrison, 2017). One of the distinguishing features of grounded theory is that the data collection and data analysis take place simultaneously, with each part informing the other (Charmaz & Thornberg, 2014; Glaser & Strauss, 1967; Strauss & Corbin, 1990; 1998).

3.1.2 Child Voice

In addition to the grounded theory approach, as educators, the researchers hold a very strong belief in the agency of each person, in particular that of the child, in their education. The agentic nature of the child, their ability and right to shape their own environment is core to this project (Ring, *et al.,* 2021). These rights, articulated in the UNCRC (Article 12, UN 1989), are at the centre of this research. The importance of the child's voice and recognising that prioritising "participation" is core to developing a democratic education which is built on a model of partnership (Martin & Forde *et al*., 2015; Whitebread & O'Sullivan, 2012; Rinaldi, 2012). Participation enhances children's self-esteem and confidence, promotes their overall development and enhances their sense of autonomy, independence, social competence and resilience.

Lundy's rights-based model of child participation was employed because it ensures that all children's views are valued and respected (Lundy, 2007). It highlights four components (space, voice, influence and audience) that are necessary to ensure that Article 12 of the UNCRC is achieved (see Figure 1.1); promoting purposeful engagement with children, challenging tokenism and moving beyond children as objects of research (Montreuil *et al.*, 2021; Harmon, 2020; Treacy, 2015; Treacy & Leavy, 2021).

Figure 1.1: The Lundy Model of Participation

(Source: Department of Children and Youth Affairs 2015, p. 21)

3.1.3 The Lundy Model of Participation in Action

Space: The Lundy Model of Participation begins with creating a safe and inclusive space for children to express their views. This space is a pre-requisite for children to express their authentic views, without fear of rebuke and reprisal (Lundy, 2007). This is not just a physical space, but a space for voice to be heard and appreciated and not just in a tokenistic way. In this research study, great care was taken to explain the importance of hearing children's views, regardless of what those views were.

Voice: Developing opportunities for conversations with young people in education has increased as a result of the interest in the study of young people's social practices, and the impact of their engagement with their culture on their relationships with themselves and the world. Nobody expresses themselves in the same way and, once a safe space has been created (Lundy, 2007), the researcher must give due consideration to how each child's voice can be heard. Voice can be articulated in a variety of ways, and it is not just restricted to the spoken word. It is imperative that thought be given to multiple means of expression, as well as the silent voice in the setting (Harmon, 2021). In this research study, a toolbox of methods was designed (3.2.2) to access child voice.

Audience: A principal reason for the development of the Lundy Model was to emphasise that voice is not enough and that children have a right to an audience and that those hearing their voice should have some ability to effect change (Lundy, 2007). This can happen in a variety of ways, sometimes those who hear the voice can effect changes, other times they may be required to open channels of communication to ensure that the voice is heard in the appropriate forum. For Lundy, it is moving beyond just listening, to what Harmon (2021) calls listening with purpose. At the beginning of the process the children must know who that audience is; clear and open communication is fundamental. In this research study, the children were informed their audience was the National Council for Curriculum and Assessment (NCCA), who work on behalf of the Minister for Education.

Influence: A major challenge to employing a child's rights approach to voice is ensuring that the adults move to a place of purposeful listening. Purposeful listening allows the adult to be open to what is articulated and, where appropriate, to act for the benefit of the children. The challenge is to be open to be influenced by what children have to say and, in turn, leading to children feeling they can influence the world around them. This notion of influence captures the phrase 'due weight' in Article 12 of the UNCRC. For Lundy (2007) influence is key, children must feel they have influence and consequently when inviting children to share their views, they must be informed about who the audience is and receive information on how that audience received their view. If the children feel that their voice has influence and is respected, it will promote a culture where their voice is appreciated, in accordance with their age and maturity. In the research study, the children were aware that they were one of twelve classrooms in the country that were invited to give their views in shaping the future in mathematics education. The children were keenly aware of the influence they had through their engagement in the research.

The key four aspects for participants in the Lundy Model of Participation (2007) are outlined below. Children are:

(1) encouraged to express their views and are given opportunities to both form and express their views on what matters to them;

(2) allocated a voice through being facilitated in expressing their views freely (this is not dependant only on their ability to form their position, whether it be mature or not);

(3) assured of their voices being heard by an audience and given due weight, as they have a right to be heard by those who have power to make decisions;

(4) assured of having their views responded to in order that they understand that their views have influence in their environment.

3.2 Data Collection

3.2.1 Procedure

Data was gathered throughout the project, for example, children had opportunities to gather data in the form of photographs of their mathematics work over the course of several weeks. This data collection was supplemented by two researcher visits to the school - the initial visit followed several weeks later by a longer visit in which substantial additional data gathering took place. In line with respect for anonymity and privacy, participants (including the researchers) were referred to, at all times, by their first names alone. The use of the children's first names in the research report places each child at the centre of the research, as indeed the children were. It further adds vibrancy and immediacy to the report. However, all of this must be weighed against the children's rights. Because anonymity and privacy are imperative, the researchers changed all first names used in this report.

3.2.1.1 Visit 1: Introduction

One of the keystones of engaging in research with children is relationship building between the researcher and the children from the outset. The introductory visit was facilitated by one member of the research team and this person was joined by another member for visit 2. By ensuring this continuity, the children had some connection with the team and so a space built in relationship was created for their engagement in the research.

During the introductory first visit, the children were introduced to the focus of the research and time was given to explore their initial views on mathematics. The research was put into context for the children based on the Lundy Model for Participation (2007). They were informed of the purpose of the research and how it would influence the future of maths in the primary classroom going forward, they were advised that the findings of the research would be shared with the people who design maths programmes for school and this group were called the National Council for Curriculum and Assessment (NCCA). The children were informed that even if their parents had given consent for them to participate, they had the right to not assent to participate or at any stage withdraw from the research. In having this conversation with the children, it gave them ownership of their participation and placed them at the core of the research.

The children were then introduced to some of the data gathering tools, their views were noted, and their questions were answered. They were also introduced to the photovoice methodology. This was framed within the ethics of taking photographs and what was appropriate and not appropriate to capture. Each class of children were then given three instant digital cameras and basic photography skills and camera use were explored. The children were invited to take pictures based on the following focus question:

> What would you like to share with me about maths when I return to visit your class?

This question was given further context in the following reflective questions:

- What did you find interesting in maths?
- What did you find challenging in maths?
- What ways did you learn or engage with maths?
- What did you find helpful in maths class?
- What maths (content and/or activities) would you keep going forward?
- What maths (content and/or activities) would you change going forward?
- Things you enjoy in maths
- Things that you are proud of when you were doing maths

The advantage of the digital cameras was they gave instant printouts to the children, on which they could write their initial reflections or reason for taking the picture. Children stored the photograph in an envelope for the next visit of the researchers. Cameras also saved the digital version of the photos on their hard drives; these were downloaded by researchers on the second visit and viewed ahead of the photovoice workshop to ensure that all images were appropriate, within safeguarding regulations.

3.2.1.2 Visit 2

Depending on the school setting, the researchers used a variety of methodologies from the toolbox (section 3.2.2). This ensured that the most appropriate strategies were employed to make sure that the voice of all children was accessed. All conversations were audio recorded and later transcribed.

3.2.2 Methods

Fostering authenticity in child voice research has proven challenging, and in order to prevent tokenistic participation, requires researchers to actively involve children in the research process (Montreuil *et al.*, 2021; Harmon, 2020; Treacy, 2015; Treacy & Leavy, 2021). Such involvement views children as agents rather than objects, and enables children's views to be interpreted through child-centred outlooks, rather than solely through adults' views of their experiences (Ring *et al.*, 2021; Montreuil *et al.*, 2021). Thus, one of the fundamental aspects of the research is that no single method is sufficient to capture the essence of the phenomena. Data collection in this study was therefore carried out using multiple methods. A toolbox of participatory methods was created to encourage authentic conversation in the research settings. All activities were designed utilising the principles of universal design for learning, with the aim of capturing the richness of the conversations about mathematics. This toolbox of participatory methods included (1) photovoice, (2) draw and tell, (3) student as journalist (including vox pop) (4) strand ranking activity, and (5) focus group interviews.

3.2.2.1 Photovoice

The taking of photographs by children as a data gathering exercise has been recommended by many (Shaw, 2021; Vu Song Ha & Whittaker, 2016). Photovoice has been described as "a powerful participatory action research method where individuals are given the opportunity to take photographs, discuss them collectively, and use them to create opportunities for personal and/or community change" (Enright & O'Sullivan, 2010). Through utilising this methodology, it is possible to listen to 'the things that are unsaid' (Thomson, 2008). The taking of pictures was therefore used as a data gathering exercise in this study. During visit 1, as outlined in 3.2.1.1 children were introduced to this methodology.

In visit 2, the photographs were used to support the discussion within the groups, as the children were invited to create a poster entitled 'What happened in maths while you were away?' (Shaw, 2021; Einarsdóttir, 2007). The posters were presented by each group to the entire class, the conversations were audio recorded and later transcribed.

3.2.2.2 Draw and Tell Activity

Drawing is an activity that most children enjoy. Haney et al. (2004) viewed drawing as a method that allowed children to express their personal identity as part of the research journey. Through drawing they are enabled to articulate their feelings, emotions and experiences of a situation, it also allows them to have an aid when sharing their story orally. The methodology allowed all children to share their voice through a number of ways, as advocated for in the Lundy Model of Participation (2007).

As part of the toolbox, children were invited to 'Draw doing maths in the classroom'. This activity required the children to draw their own picture of what they perceived as 'doing mathematics'. They could label the picture or write a short narrative to explain the picture if they wished. This provided researchers with an insight into how they perceived and experienced maths in their education, while allowing the children a very creative way of sharing their voice. The researchers moved between the children as they were drawing and children were invited to describe and explain the features of their drawings, if they wished. These audio recordings were later transcribed.

3.2.2.3 Student as Journalist (Child-led Interviews)

Children were invited to collaborate with each other in the roles of interviewer and interviewee in exploring questions relating to their learning experience of maths. At the end of the interview period, this approach usually involves inviting the class to create a number of articles that would form the front page of a newspaper thus bringing together the views of the children, while promoting discussion and teamwork. While this was a component of the toolbox, it was not used in any setting, but its principles were adapted. The adaptation involved a vox pop in which the students engaged with the following question: What would you advise the Minister of Education, Norma Foley about maths today and into the future? Through the adaptation of Student as Journalist, it highlighted the importance of the influence that the child had through their engagement in the research, once again embedding the Lundy Model of Participation (2007) within the research.

3.2.2.4 Strand Ranking Activity

The children were invited to participate in a ranking 'activity'. This involved placing the children into groups of 6 and distributing the 5 strands of the maths curriculum (number, shape and space, measurement, algebra, and data and chance) on laminated cards. Children were asked to rank the strands in whatever order they wished, considering what they viewed as most important or least important, liked most or least and whatever other criteria they decided upon as a group. The ranking could be organised vertically, horizontally or a mix of both. This is a thinking skill tool (Rockett & Percival, 2002), which allows the groups to reflect on their choices, work collaboratively and make explicit their rationale as they rank the strands. These conversations gave insight into how the children understand the strands and the values they attribute to them. This activity highlights the importance of the child's autonomy in articulating their voice within the research (Lundy, 2007).

3.2.2.5 Focus Group Interviews

Flick (2009) advocates group interviews, as they better reflect the way opinions are expressed and shared in a natural environment. They also provide opportunities for respondents to challenge or correct statements that are not correct or shared by the group. While Flick (2009) recommends that such groups should comprise strangers rather than friends, this did not apply to the present study, as the children were in class with each other each day and their relationship with each other was an essential part of the research. While the groups should ideally consist of four to eight people, those in this study comprised of six children. Each of the groups had a mix of learning abilities. This mix allowed for conversational depth.

Interview schedules consisted of open-ended questions to encourage the children's views and to allow for the development of thought and probing of responses. Robson (2002, p.41) explains that an interview schedule is "a shopping list" of questions and stresses the importance of including thought-provoking questions in semi-structured interviews. At all times, great efforts were made to put the children at ease and interviews were approximately 30 - 50 minutes in duration. Children were asked for their permission to record the interview and were reminded, once again, that they had the right to withdraw at any time.

Each session began with reminding the children of their right to withdraw at any time. This was followed by reviewing the children's pictures and ranking activity from the earlier session, which facilitated the researcher in seeking clarification on previous conversations. Both of these activities allowed the children to build a bond within the group, which created an appropriate space from digging deeper in the interview that followed.

3.3 Research Participants

This research involved the NCCA's network of primary schools recruited for the consultation on the draft PMC. This group consisted of fifteen schools. All fifteen schools were invited to participate in the child's voice strand of the consultation and from the fifteen schools, twelve classes were selected to partake in the research. These classes were representative of a diverse range of educational environments at primary level.

The NCCA's network of primary schools recruited for the consultation included one special school, but this school declined to partake in this consultation. To ensure the voice of children who attend such settings was captured, an ASD Unit attached to a mainstream school was included as one of the classes visited. In all, ten classes participated in the consultation. Table 1 presents an overview of the classes that took part in the study:

Table 1. Demographics of participating classes

Class	**Class level**	**Location**	**Language**
1	3rd	Urban	English
2	4th	Urban	English
3	5th	Rural	English
4	ASD	Rural	English
5	4th, 5th and 6th	Rural	English
6	3rd, 4th 5th and 6th	Rural	English
7	6th	Rural	English
8	3rd, 4th, 5th and 6th	Rural	English
9	5th and 6th	Urban	English
10	4th	Urban	English
11*	6th	Urban	Irish
12*	3rd, 4th, 5th and 6th	Rural	English

* *withdrew during the data collection phases of the study*

Vygotsky (1978) and Bronfenbrenner (1979) believe that child-centred research should take place in a setting familiar to the child, rather than in a clinical laboratory setting. Similarly, Lundy (2007) identifies the importance of a safe space for the child to articulate their views. This research, therefore, was conducted in the children's classrooms.

3.3.1 Ethics

Conducting research with children can be challenging, as outlined by Dockett, Einarsdottir and Perry (2012). Ethical approval for this project was granted by the Mary Immaculate College Research Ethics Committee (MIREC) on 21 March 2022. As this research involved participants who were under the age of 18 years and in compliance with the *Children First: National Guidance for the Protection and Welfare of Children* (2017), a thorough risk assessment was completed and a child safeguarding statement was drawn up prior to the commencement of the study, which was stringently adhered to throughout all aspects of the project. As outlined in 3.2.2.1 children engaged in a conversation on the ethics of taking photographs and prior to the children sharing their images the researcher reviewed all images ensuring they were in keeping with the aims of the project and safeguarding regulations. All of these measures were to ensure that the project adhered to high ethical standards in light of the involvement of what is classed as a vulnerable population.

3.3.2 Data Protection

As a publicly funded body, MIC is subject to the Freedom of Information and Data Protection legislation including the General Data Protection Regulation (GDPR), as set out in the the *Irish Data Protection Act* (2018). The legislation lays down rules for the collection, storage and management of information. These statutes also provide for the safeguarding of stored data as well as for access to information personal to individuals or which should be disclosed in the public interest (in accordance with certain exemptions). At all times, MIC organises and administers information in compliance with these statutory requirements and ensures that the project meets all GDPR legislation.

3.4 Data Analysis

In line with the principles of grounded theory, the data analysis process was inductive and iterative. It was also collaborative, in that, the five researchers worked collectively to interrogate the data over several months and build theory from this data. The steps undertaken are now outlined.

3.4.1 Analysis during Data Gathering

Aligned with the principles of grounded theory, data analysis began during the data gathering phase of the research process (Charmaz & Thornberg, 2014; Glaser & Strauss, 1967; Strauss & Corbin, 1990, 1998). This happened in a number of ways. First, the researchers wrote reflective memos contemporaneously with the data gathering in schools. Second, the two researchers who collected data in each school took part in de-briefing sessions in which emerging data was discussed, analysed and noted. Third, the analysis continued during transcription and cleaning of the data, which was undertaken by the researchers who had been involved in the data gathering in each school. This continuity between data gathering, cleaning, and transcription ensured that data was accurately reflected in the transcripts including, *inter alia*, any nuances, classroom environments, or unique features.

3.4.2 Initial Coding

Aligned with Charmaz (2015), initial or open coding was used to distil and conceptualise the data so that ideas could be generated and expanded. Coding involves "naming segments of data with a label that simultaneously categorizes, summarizes, and accounts for each piece of data" (Charmaz, 2006, p.43). This initial coding acted as a device to view the data analytically, that is, to analyse and label the data from "multiple conceptual vantage points" and to interrogate what the codes imply and how and why they were constructed (Charmaz, 2015). First, each pair of researchers engaged in initial coding for individual classes, resulting in a code table for each class. Second, all researchers engaged in a comparative analysis in which data was compared with other data, data was compared with selected codes, and these codes were compared with other codes to find similarities and differences (Glaser & Strauss, 1967). Resulting from this comparative analysis across the data corpus of ten classes, 71 common codes were generated. Third, this initial coding and constant comparative analysis whereby the codes were compared with each other, and with the data, led to sorting and clustering of initial codes. This sorting and clustering of codes resulted in a distillation of the codes, for example, some codes were revised, new codes were constructed by merging identical or similar codes where there was deemed to be sufficient commonality, whilst some codes were discarded.

3.4.3 Focused Coding

Focused coding and categorisation (also known as selective coding) was then utilised as the next step in the data analysis process. This allowed for more abstract categories to be compared with the data, codes, and other categories in a recurring, iterative process. First, the most significant or frequent initial codes were treated as tentative categories which were defined by their empirical properties or characteristics so that they would make analytical sense. These categories were cognitively challenging tasks; problem-solving; textbook-use; child and teacher roles; groupwork; context; mathematical talk; assessment; constructivism including hands-on/meaningful engagement; and the affective domain. These codes were elevated to tentative conceptual categories because they were considered to best capture what the researchers saw happening in the data. Relationships between these codes were assessed. Second, each of these tentative categories were used as a lens to re-interrogate the entire data corpus, that is, data from all ten classes including transcripts, photographs, drawings, and posters. Third, within each category, sub-categories were generated in tabular format to identify all instances across the school level data. This re-interrogation and comparative analysis of the data allowed for triangulation across the data sources for each school and contributed to methodological triangulation. Fourth, moving beyond the school level data, instances of the categories were analysed across the data corpus, which contributed to research site triangulation. Resulting from this comparative analysis, categories were merged, reconfigured, or collapsed. This distillation resulted in the identification of ten categories: teacher and child roles in mathematics lessons; groupwork; classroom discourse; mathematical talk; children's experiences of mathematics; mathematical textbooks; context; assessment; speed; focus on understanding / accuracy.

3.4.4 Theoretical Coding

In line with Glaser (1978), the researchers then engaged in theoretical coding in order to analyse the ways in which the codes and categories constructed from the data might relate to each other as hypotheses to be integrated into a coherent grounded theory. First, this involved the researcher's importing perspectives and ideas from a range of theories as analytical tools, for example constructivist and sociocultural theories. Aligned with Corbin's (2009) recommendation, the researchers took time to think, compare, ask questions, follow the leads, and write memos. Similar to the other stages of data analysis, this involved a constant comparative analysis. Second, the researchers compared the data with the pre-existing and emerging theories to search for patterns and to formulate the best possible explanations arising from the data. At times, this involved revisiting the data tables, and at other times it involved comparing the categories to the original raw data. The data was scrutinised for descriptors or qualifiers of these conceptual categories so that variations and nuances within the concepts could be identified, and where necessary addressed. Third, the researchers engaged in writing extensive conceptual memos which used the categories and corresponding data to create empirical descriptions of children's experiences of learning mathematics in Irish primary schools. Fourth, these conceptual memos were reviewed, and where necessary amended, based on analysis of at least one other researcher who had not been involved in the write-up of the memos. This aspect of data analysis contributed to researcher triangulation. Fifth, these memos were compared with each other, and with the original data corpus, resulting in some categories being merged or reconfigured. For example, the 'speed' and 'focus on accuracy / understanding' categories were merged into the 'children's experiences of mathematics' category; whilst the 'mathematical talk' and 'classroom discourse' categories were merged with the 'group work' category to create a new category titled 'children's experiences of collaboration and communication in mathematics'. The remaining seven conceptual categories were identified as the most prominent themes that emerged from the data. These themes were then further analysed to create sub-themes. The themes and sub-themes are outlined in table 2 below.

Table 2. Themes and subthemes identified from qualitative analyses of the data

	Theme	Sub-themes
1	**Children's experiences of collaboration and communication in mathematics**	Children's experiences of collaboration Children's experiences of communication when doing mathematics
2	**Children's perspectives on teacher roles in the mathematics classroom**	Teacher as explainer Teacher as helper / supporter Teacher as 'other'
3	**Children's experiences of mathematics**	Mathematical tasks are experienced as traditional procedures-based activities Preferred mathematics experiences Desire for more variety Problem solving Right Answers Speed
4	**Children's experiences of mathematics textbooks**	Variation in textbook use Children's reactions to mathematics textbooks Children's critique of textbooks

		Children's thirst for mathematics experiences beyond the textbook Children's experiences of textbook-free mathematics learning
5	**Children's experiences of context in mathematics**	Appreciate and value the role of context in mathematics Desire to experience more meaningful and context-driven mathematics
6	**Children's experiences of challenge in mathematics**	Welcome and enjoy challenging mathematics tasks Value success and knowing when to expect a challenging task Experiences of cognitively challenging tasks in one class
7	**Children's experiences of assessment**	Affective responses Recommendations from children

3.4.5 Children's Voices

Throughout the data analysis process, the integrity of the data was paramount, for example, the researchers continually returned to the data to ensure that the initial codes, and later the tentative categories were truly reflective of the data corpus, so that variations and nuances, both within and across schools, could be highlighted and included in the theoretical codes. Underpinning all this data analysis, and aligned with Lundy (2007), was a desire to give effect to children's right to have their voices heard in matters that impact on their lives. Consequently, during data analysis the researchers consistently aimed to give due weight to children's perspectives about learning mathematics, and to be respectful of their experiences and opinions.

4.0 Findings

The findings are presented under seven themes and associated sub themes.

4.1 Theme 1: Children's experiences of collaboration and communication in mathematics

4.1.1 Children's experiences of collaboration

4.1.1.1 Working alone

4.1.1.2 Helping each other

4.1.1.3 Sharing Strategies

4.1.1.4 Working together on problems

4.1.1.5 Group work as social and fun

4.1.2 Children's experiences of communication when doing mathematics

4.2 Theme 2: Children's perspectives on teacher roles in the mathematics classroom

4.2.1 Teacher as explainer

4.2.2 Teacher as helper/ supporter

4.2.3 Teacher as 'other'

4.3 Theme 3: Children's experiences of mathematics

4.3.1 Mathematical activities are experienced as traditional procedures-based activities

4.3.2 Preferred mathematics experiences

4.3.3 Desire for more variety

4.3.4 Problem solving

4.3.5 Right answers

4.3.5.1 Focus on the right answer

4.3.5.2 Focus on multiple correct solutions

4.3.6 Speed

4.3.6.1 Focus of speed

4.3.6.2 Focus on understanding/accuracy

4.4 Theme 4: Children's experiences of mathematics textbooks

4.4.1 Variation in textbook use

4.4.2 Children's reactions to mathematics textbooks

4.4.3 Children's critique of textbooks

4.1 Theme 1: Children's experiences of collaboration and communication when doing mathematics

4.1.1 Children's experiences of collaboration

Working with others was referenced by each class, with only one class reporting that they never do group work. When making suggestions for the future mathematics curriculum during the focus group, they [Class 5] state that:

Jake:	I think there should be more class activities like ones you can do, like with your friends .... like work together.
Researcher:	That was going to be my last question for you all and we didn't speak about that an awful lot. Group work .... working together, working on your own. What's happening with you? What's your experience?
All children:	No, no.
Leah:	Not really

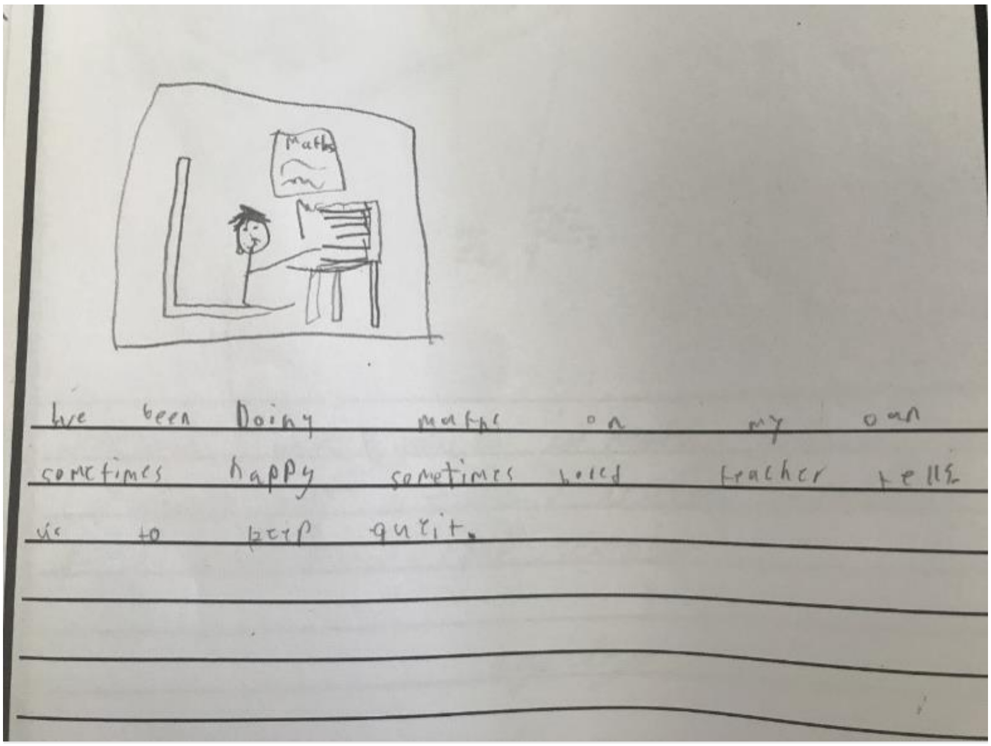
Jake:	It's all book work. Last time we done group work was today.
Roisin:	And we never do group work.
Leah:	We mostly just write our books.

The remaining nine classes acknowledged that they had engaged in some form of group work. Their description of group work, however, and what it entailed varied greatly, and this appeared to influence their perceived benefits of collaboration. Their experience and understanding of group work ranged from just sitting in groups; working alone and checking answers at the end; helping each other if they were stuck; purposively sharing strategies; to collaborating on problems and mathematical activities together from the beginning. The following sections outline their experiences.

4.1.1.1 Working alone

"I can do things one way, I don't really need to discuss it with anybody"

Mathematics was portrayed by some children as an individual endeavor, where children worked quietly and by themselves, as suggested in the drawing below:



[Class 9, draw and tell]

For the most part, references to working alone were portrayed negatively. While there was an appreciation that the teacher has a difficult activity in trying to help everyone at the same time, these children could see potential ways of supporting each other through collaboration:

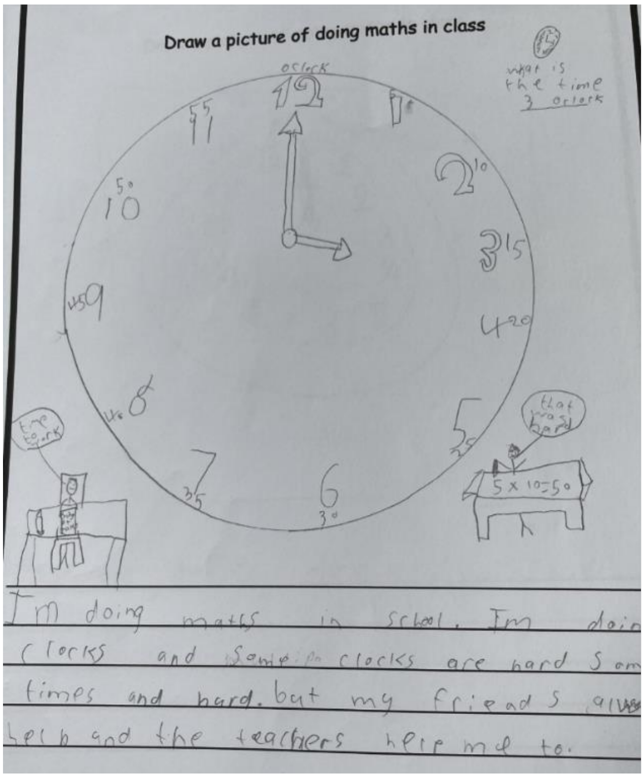
> Sometimes, like our teacher doesn't let us talk to the person next to us. And then teacher has like other people to be going around and explaining to. Just sometimes I feel like she should just let us like, get help from the person next to us [Class 9, focus group].

For other children, group work meant sitting in groups, and working alone for the most part. Where meaningful group work was not a class norm, some children found it difficult to recognise potential benefits: "I like doing things by myself and having a partner takes...? I can do things one way, I don't really need to discuss it with anybody" [Class 6]. Others added that working in a group could be useful for corrections. In this case, sitting at a group would allow them to work individually and to *check* for the correct answer at the end, without necessarily sharing *how* they got it: "If one has a wrong answer and everyone else has the right answer, we'll know who's probably right" [Class 6]. Another child's description of this sort of group work demonstrated the incidental nature of some of these engagements: "Well if you can't think of it, then, in moments later you'll hear the answer [from someone else]. Or you'll be able to hear where you go wrong" [Class 6].

4.1.1.2 Helping each other

"I love group work. It's just if you're stuck on something you can ask your friends".

The key benefit of working together, as identified by children across the data set, was the opportunity to seek and offer peer support. Very often, this was characterised as an incidental event, in which a child asked someone in their group for help when they were stuck. In contrast to the silent, individual work above, many classes promoted this open discussion at tables, and children were encouraged to discuss a problem with their partner first, and "if your friend didn't know something.... you could ask the teacher" [Class 2]. Children drew their "friend coming over to help" [Class 4] and relied on their support when they came across a difficult topic, as depicted in the image below [Class 2, draw and tell].



[Class 2, draw and tell]

There was a sense of ownership, on behalf of some children, who realised that helping each other was a form of peer learning, in which both parties could benefit, with one child stating, “you know, like people say, well, helping other people will help you as well” [Class 3, focus group]. Children recognised the importance of peer support, and valued the contributions they could all make, as evident in this focus group excerpt from class seven:

> Because we're all kind of on the same boat studying. If somebody doesn't understand that, I'm sure there's somebody else doing it that also doesn't understand it. But you can work together from the key elements you picked up and put them together and see [Class 7].

In fact, three classes suggested that children themselves are in a better position to support their peers and explain concepts or procedures to each other [Class 2, 9, 10]. They advised that “as a kid, they’d probably still like, explain it like slower and in a more ‘our age’ way”, as opposed to an adult’s explanation, that would be “what they learn at the age they’re now” [Class 2]. Children also felt that sometimes they don’t understand the way teacher explains and could benefit from “someone else’s perspective” [Class 9].

4.1.1.3 Sharing Strategies

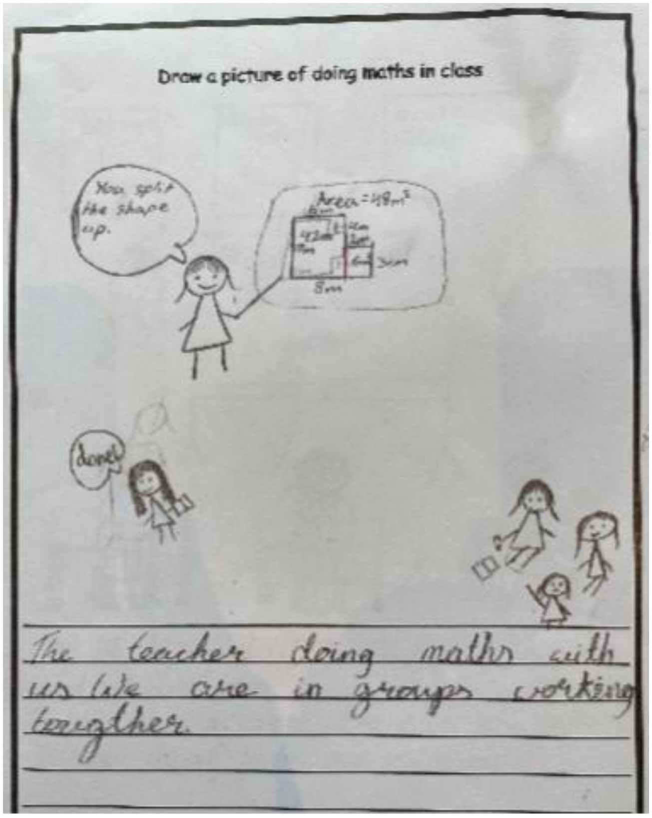
"You get to learn from your mistakes, to learn how other people work it out".

While some saw group corrections as a time to check for right and wrong answers, other classes used it as an opportunity to share strategies.

Nicole:	When we're doing area, sometimes three or four people gather in a group
on	the ground and do it together... we do it a good bit.
Researcher:	And what's happening when you're working together like that?
Peter:	We'd all be explaining what we got. If someone was wrong, we'd all
look at	our stuff. If nobody got a wrong, like em, that's all because we worked together!

[Class 3, draw and tell]

It was evident from the children's data in this class, that ownership was encouraged by the teacher, who "is always telling us you'll learn more from each other than you would from the book" [Class 3, strand ranking activity].



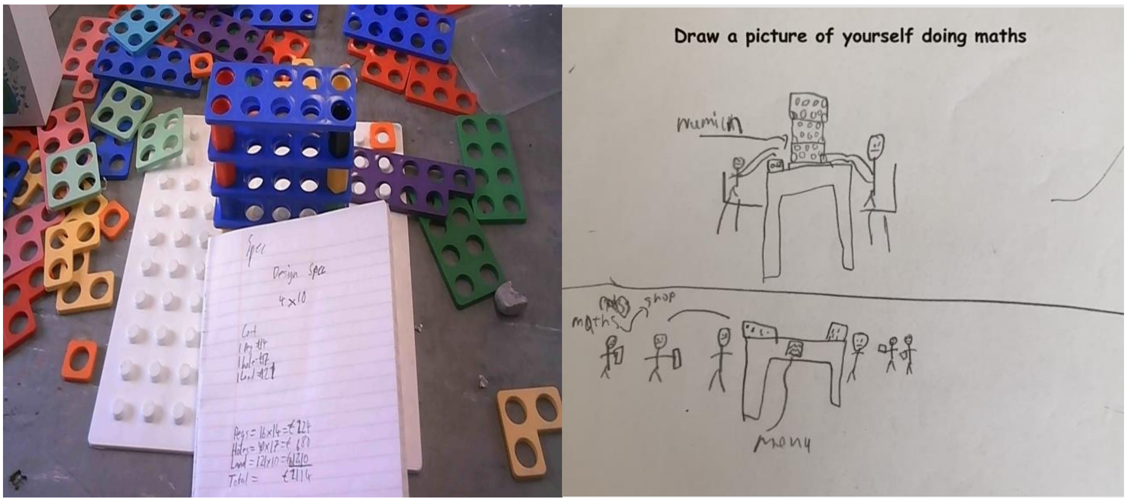
[Class 3, draw and tell]

Other children embraced new opportunities to "share[d] my ideas with my partner" [Class 9, photovoice] during recent interventions. One child came to realise the importance of "just listening to math solving problems, because you might use them sometimes", while another stated that "you get to learn from your mistakes, to learn how other people work it out" [Class 9, photovoice]. This is discussed further in the section on *communication* that follows.

4.1.1.4 Working together on problems

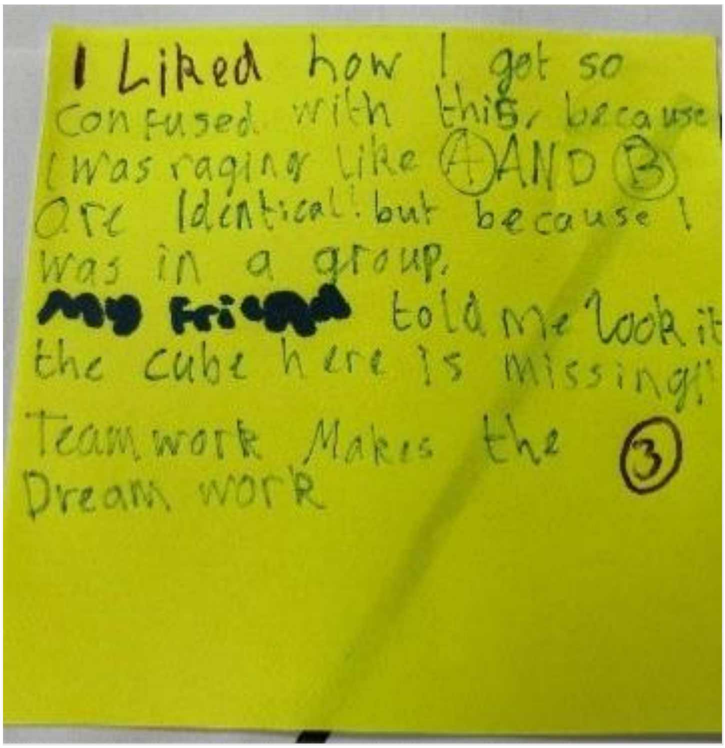
"We combine our heads... like we work together"

For two classes, peer learning was an integral part of their mathematical experiences. Collaboration for these classes meant working on a problem together, from the very start: "We combine our heads... we like worked together" [Class 3, photovoice]. Class ten, in particular, gave many examples of collaborative inquiry and project-based learning activities they engaged in, such as the design activity in the drawing below.



[Class 10]

In her photovoice poster, one child in class three, described how working collaboratively on a problem allowed her to move beyond a point where she was stuck, to go on to solve the problem. She liked how she "got so confused...but because I was in a group my friend told me 'look it, the cube there is missing'. Teamwork makes the dream work" [Class 3, photovoice (below)].



[Class 3, photovoice]

Children in class ten showed mature understandings of group work, with one child suggesting that effective group work needs negotiation “because you’re talking [about] how to do it, and you might disagree on something”. Indeed, children in class ten could identify developments in the quality of their collaboration, and understood what effective group work was about, as outlined in the following focus group excerpt:

Researcher:	Were you always good at group work...?
All:	It’s gotten much better
Mark:	Cause last year when we group worked, it was kind of like you, you used the group, but it was kind of… you mostly actually did it by yourself... you’d be in a group- you'd just be talking, but then you just make your own answers. But this year, I feel like, I am anyways, like working with the group more. So, like we actually say, maybe this is the answer or maybe this is the answer, and we tell each other why. Before we used to just say the answer and were like no, this is the answer and we solved it, write it down.

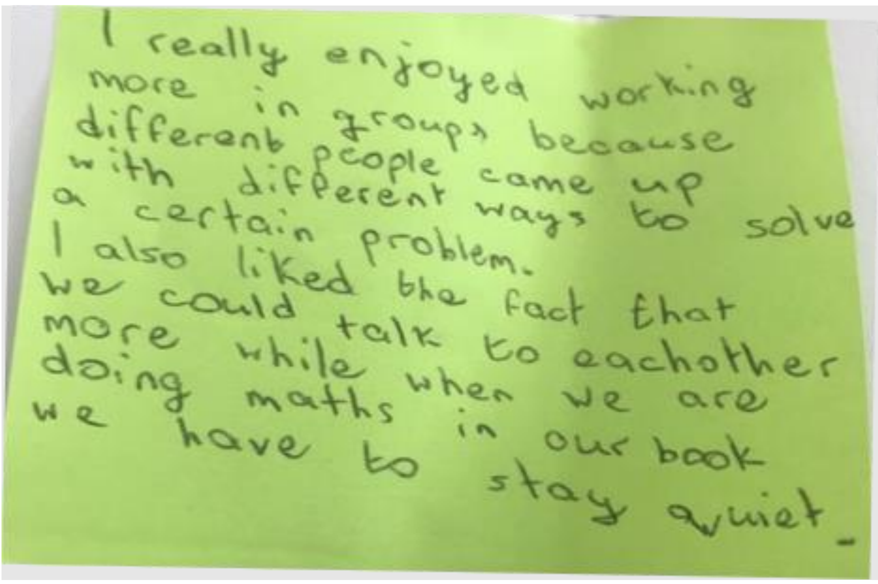
Children with experience of genuine group work, such as those in class ten, strongly advocated for the inclusion of more peer collaboration in mathematics. When asked what message they would like to send the Minister of Education, one boy stated “Don’t do maths by yourself. And then the thing I want to put in, is always do group work and stuff like that”, while another girl agreed, suggesting, “like get rid of people like not doing group work and keep people doing group work” [Class 10, vox pop].

4.1.1.5 Collaboration as social and fun

“It’s a much more pleasant experience”

Data from across the ten classes referred to the social element of group work, the opportunity to work with your friends and the perceived enjoyment associated with collaboration. When presenting on a group maths project they completed, one group suggested that it was “fun just working with someone that I knew in teamwork as well” [Class 3, photovoice]. Another child stated that “cooperating with people” was important to her, because “even if it’s like a really boring subject... it is a bit more fun” [Class 10]. Some classes had recently tried to incorporate more group work in mathematics, and the children displayed a real thirst for further collaboration, as outlined in one group’s presentation (and associated photovoice image below):

> Yes, it’s definitely more appealing... When you do it with two people you get to talk, bounce ideas off each other. And it’s a much more pleasant experience. And that’s why I would like to do more work in duos and all this [Class 9, photovoice presentation].



[Class 9, photovoice]

Apart from some isolated reports of preferring to work alone "because I won't have anyone distracting me" [Class 1] most classes advocated for more group work. Even classes in which group work was not the norm expressed a desire for more collaboration. Some children advocated for more choice, as is evident from this focus group [Class 1] extract;

Caine:	I think we do more of some types. I think we do individual work a bit more than... [group work]
Researcher:	And if you were going to give a message to the minister, would you keep it that way?...
Caine:	I'd say we could do more things. It doesn't only matter, just we do all the same stuff all the time
Researcher:	Okay, like more variety?
Caine:	Yeah, more choice.

It should also be noted that children reported collaborative work most often in the strands of *Measure, Shape and Space* and *Data*. In fact, when asked why the *Numbe*r strand was placed at the bottom of the strand ranking activity, one group stated that they do "more in the book. So, you don't get to work as much together for number... you just got to do it kind of" [Class 3].

4.1.2 Children's experiences of communication when doing mathematics

"We don't talk, teacher does"* v "*maths talk with your partner or... maths talk to the group"

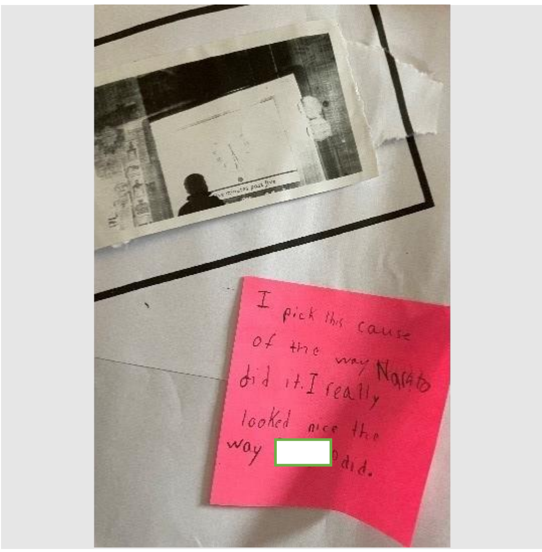
As can be seen in the children's responses above, talking and communicating was viewed as an integral element of group work. Accordingly, classes that reported little or no groupwork placed less emphasis on the role of discourse in mathematics. When presenting their posters, one group was asked if they talk a lot about mathematics:

All:	No
Researcher:	Anybody else .... do ye talk about maths?
All:	No
Researcher:	When you're doing maths, do ye talk?... Do ye ever chat with each other? Talk to other people about maths...like when you're doing the trundle wheel outside?

Ceire:	Yeah...What's the answer.
Darragh:	We ask what's the answer.
Researcher:	And would you talk about how you'd be doing it? Do you talk a bit?
Breed:	Yeah, we don't talk. Teacher does.

Children across four classes specifically referred to the importance of '*communication'* [Class 1,3, 9, 10] in mathematics. Sometimes this took the form of one child 'explaining' a concept or procedure to another, or it involved two or more children sharing approaches and strategies. In many cases, however, this was incidental, and arose from one child asking a friend at their table for help. Other times it was more structured and explicit, with the teacher encouraging the class to "maths talk with your partner or... maths talk to the group" [Class 10, focus group].

Children also reported on their experience of whole class activities. Frequently, this involved people coming up to the "board to explain the process" [Class 1, photovoice presentation]. A similar activity, (referred to by another child as *narrative* or *narrating*), was chosen in the photovoice image below, as "he [a child] said it out loud, for people who didn't understand it, and it really helped me kind of learn it a bit more" [Class 2, photovoice presentation]. The same child later recommended that she would "keep narrative, [be]cause it helps you understand more" [Class 2, vox pop] in the new curriculum.



[Class 2, photovoice]

[Class 1, photovoice]

Another class referred to their experience of brainstorming mathematical language relating to money [Class 1, photovoice picture above], before beginning the strand unit. The children valued the opportunity to share prior knowledge. Similarly, this class stated that "we really think after every maths lesson we should talk about, well, what we just done in maths" [Class 1, vox pop], indicating the importance of discussion at the end of a lesson also.

For class ten, talk was central to everything in mathematics. They stated that *maths talk* was necessary throughout the curriculum as it "kind of works with all of the … every, all things with maths. Just all these" (pointing to the strand cards) [Class 10, focus group]. Maths talk was described as focused and purposeful, "like when we're talking maths, it's ok. If we're not talking about maths, you can't be talking, but you can talk about maths". They spoke about maths talk in terms of "explaining strategies" and "learning new strategies" [Class 10, strand ranking activity]. For them, maths talk provided clarity and understanding:

> It solves all of your answers because it kind of puts you under pressure if you're not kind of in maths talk, because if you have the wrong answer, but your friend has the right one, they would kind of like... you would agree on it. And then you will know the answer more than you used to before you talked [Class 10, focus group].

From the children's descriptions, it appeared that maths talk was the pedagogical practice that supported them during the cognitively challenging activities (see also section on *Challenge*). Maths talk was seen as something that could happen anywhere, at any time, to help you work through challenge and get 'de-clunked' as outlined in one photovoice presentation:

Moll:	Like group work or like individual work, you can like maths talk with your partner or maths talk with your pod. For like Numicon (design activity) you maths talk with the person you're working with. If you're clunked... when you're clunked, you make a sign (makes a kite shape with his thumb and first finger). It means... you show it to the teacher, and then that means you're stuck on a question or something, and then you'd have to try to get de-clunked.
Researcher:	And how do you get de-clunked?
All:	Someone else helps.

Ryan	No, you ask the class.
Dimitri:	The teacher sometimes. If the class can't help the teacher does.

Maths talk was highlighted many times across class ten's data set as a key enabler in developing conceptual understanding, and in getting "rid of your clunky". By engaging in maths talk the children could become unstuck and move on:

Daire:	Usually, we can declunk the person...if we can declunk, if we can't declunk the person then the teacher does
Shauna:	but most of the time we do
Daire:	[declunking is] really important. Like you won't know what to do with it the rest of your life.

It is clear that children across the participating classes had varied exposure to communication in mathematics. There was evidence to suggest, however, that children who were not encouraged to share strategies, or hear other people's approaches, could still identify the potential benefits, such as one child's suggestion that you "could learn from someone else's way to find the best way and the easiest way for you to do it" [Class 9, focus group].

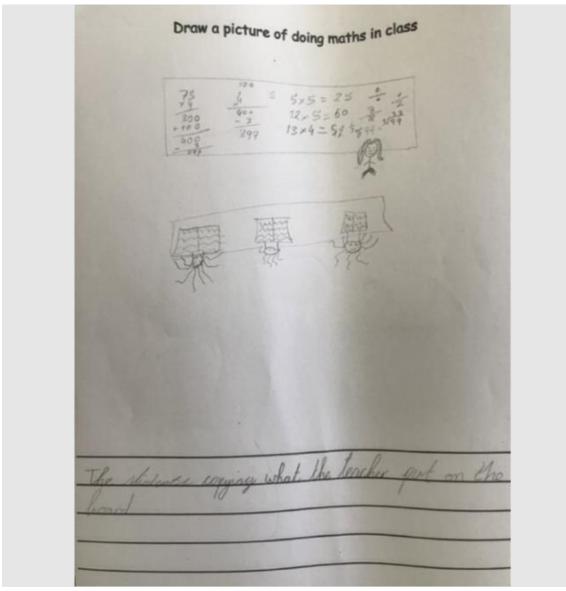
4.2 Theme 2: Children's perspectives on teacher roles in the mathematics class

4.2.1 Teacher as explainer

"Showing how it's done"

When asked to *'draw a picture of doing maths in class*', many children included their teacher. Very often the teacher was depicted as the central figure. They were seen as the person "explaining and talking about how to do different things" [Class 7], or "showing how it's done" [Class 5], while the "students are copying it down in their copies" [Class 9].

[Class 5, draw and tell]



[Class 9, draw and tell]

In her drawing of doing mathematics in class, one girl drew her teacher "explaining some like multiplication" while the children are "putting the stuff on the board in their examples copy. Like just so they can see it again if they don't understand" [Class 5]. Some children see 'doing mathematics' as *following teacher's steps,* as evident in the image below [Class 9]. Similarly, a traditional *I do, we do, you do* approach was reported when describing the teacher explaining the...

> Formula and how to do it. And then [the teacher] gives them examples to do and they like, they all get to work in a group. And then like, if they're a bit stuck, they can ask

each other questions, but if none of them know they can ask the teacher questions. And then she'll do another explanation. And then after a while they'll get it and then they'll know how to do it [Class 7, draw and tell].

[Class 9, draw and tell]

For one child there was a familiar reassurance when the teacher wrote "stuff up on the board, so you know what to do and exactly how to do it, so you feel comfortable about it" [Class 7]. However, others cautioned against the approach, and its potential to be "repetitive" [Class 7].

4.2.2 Teacher as helper/ supporter

"They help you if you're ever stuck"

Others highlighted the role of *teacher as helper*. In many of the drawings of mathematics class, such as the one below [Class 2], children identified themselves as being stuck on a problem or activity and asking the teacher for assistance. For some children, seeking help from the teacher, or another adult, was the first option when stuck:

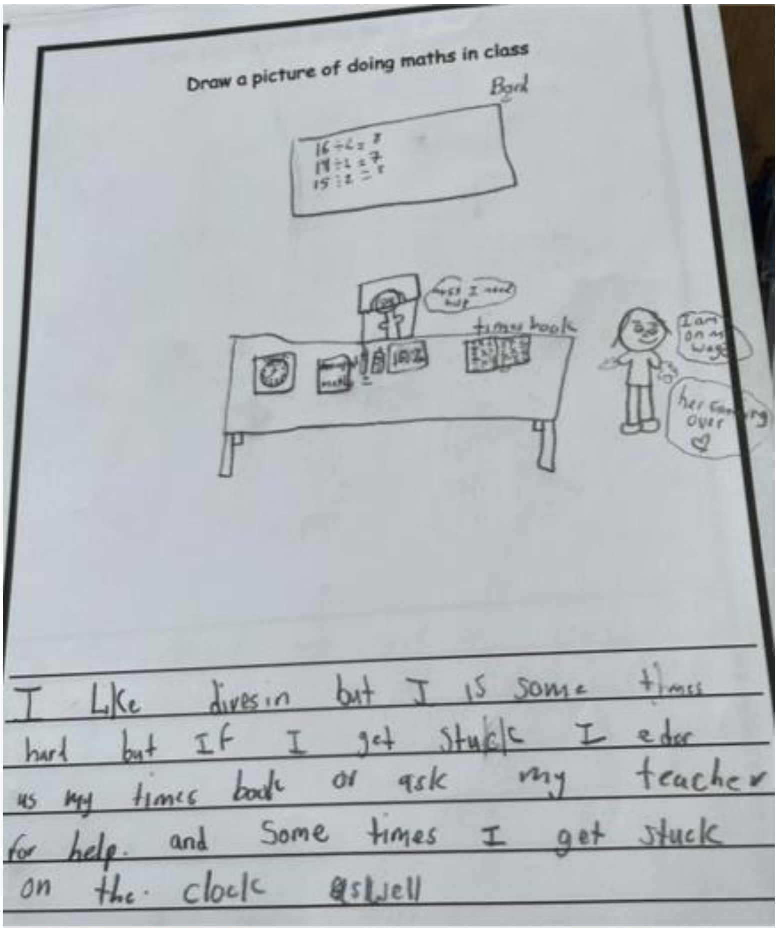
Researcher: What do you do if you get stuck on something tough in maths?

Ottilie: Ask the teacher.

Kingston: SNA.

Maeve: Well, I try to push through. And if I can't then, I just ask for help.

[Class 4, focus group]



[Class 2, draw and tell]

This was viewed as a supportive role from the teacher, who is always “gonna be over there watching” and “coming over” [Class 2] to the desk when help is needed. Indeed, when asked if the children had advice for new teachers, one child made a suggestion related to teacher role:

> I think what makes a good maths teacher is that they explain it, they explain it like so you’re able to understand...and they help you if you’re ever stuck. Like if you’re ever stuck on something, they’ll be able to understand that like, what you’re stuck on [Class 2, vox pop]

4.2.3. Teacher as ‘other’

While descriptions of teacher as *explainer,* and *helper* were dominant across the data sets, it should be noted that three classes (notably those classes reporting more group work and communication [Class1, 3, 10] above) made very little reference to their teacher or the role of the teacher across all data sources. The teacher role was de-emphasised, and references to them related to providing materials or orchestrating discussions and activities, such as those described in class one:

> “The teacher gave us like a magazine and we have to figure out which one was the most expensive and the cheapest”
>
> [Class 1, photovoice]

> “We're saying words about money and teacher was writing them down”
>
> [Class 1, photovoice]

> “Teacher will give us to chalk and we can like draw something on the floor”
>
> [Class 1, vox pop]

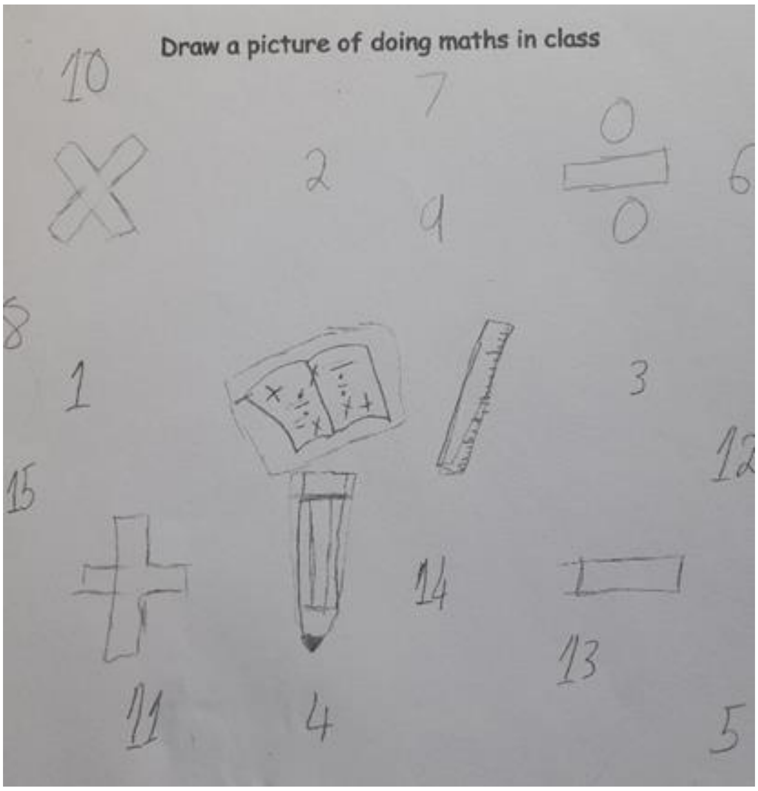
It could be inferred from the children’s descriptions that the perceived role of the teacher in these instances was more facilitative, with the emphasis being placed on children leading their own learning.

4.3 Theme 3: Children's experiences of mathematics

4.3.1 Mathematical activities are experienced as traditional procedures-based activities

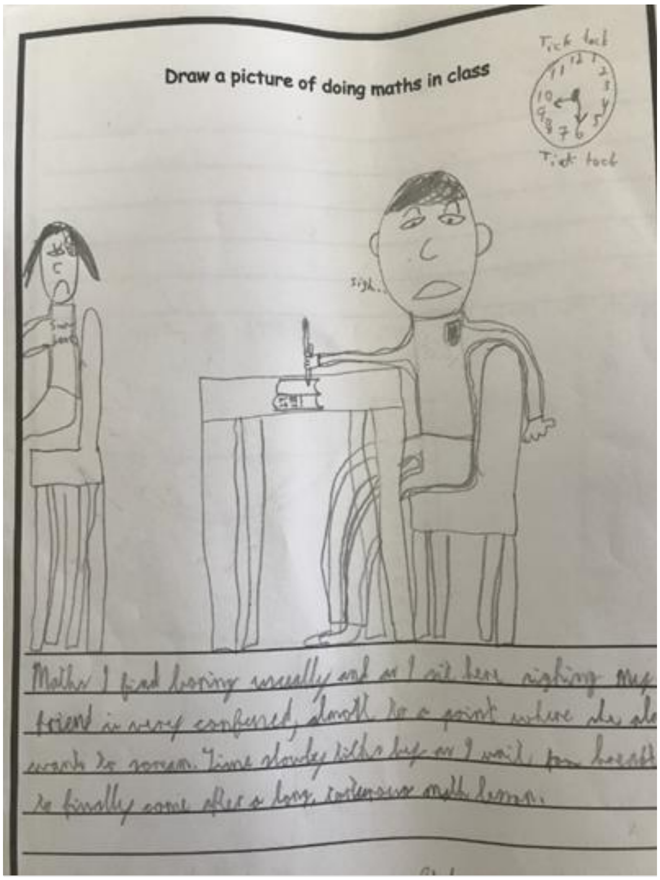
"You're just doing sum after sum"

Across the data collection methods, children provided details about the nature of mathematics activities they engaged with and their feelings about these. They also made recommendations to the Minister for Education in light of their experience. Across some classes, children's commentary and drawings (example below) suggest that they associated doing maths with completing mathematics procedures, where "to do maths, you need to have like a process or a formula" [Class 7, draw and tell]. One child did not perceive engaging in maths games as doing "proper maths", explaining "we haven't been doing proper maths but we have been doing maths games … proper maths is like multiplication, actual work, division, working with [names a textbook series]" [Class 9, draw and tell].



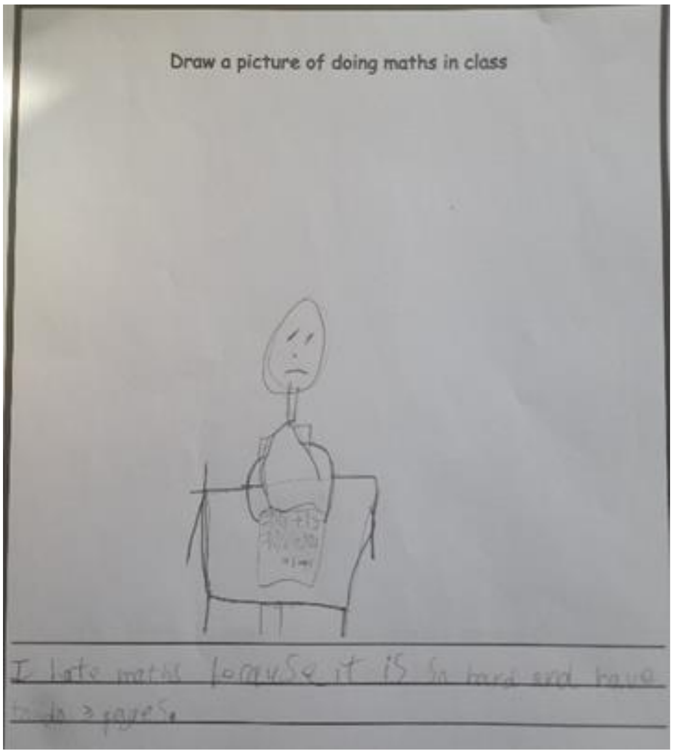
[Class 6, draw and tell]

Children who reported a predominantly procedure-focused learning experience communicated their lived experiences. For example, when asked to describe their drawing, one child provided a vivid insight “Doing the multiplication as time slowly ticks by...Because to me, it just seems like kind of a bore when you're just doing the maths. You're just doing sum after sum. A long time to lunch [Class 9, draw and tell (below)].



[Class 9, draw and tell]

Many of the children communicated negative emotions in response to their “repetitive and boring” [Class 7, photovoice] mathematics experiences: “So this is me doing maths. I'm depressed and sad because...it's kind of boring” [Class 9, draw and tell]. One child simply stated: “I hate it” [Class 6, draw and tell (below)]. In contrast, other children conveyed positive emotions related to completing mathematics procedures. These included enjoyment “trying to figure sums and all out” [Class 8, strand ranking activity] and satisfaction: “I see myself like breaking down sums. And I see myself happy after doing them” [Class 9, draw and tell].

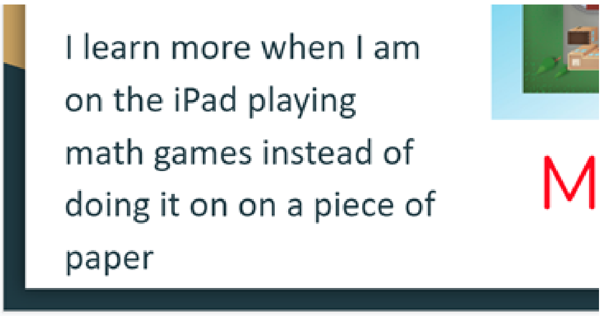


[Class 6, draw and tell]

4.3.2 Preferred mathematics experiences

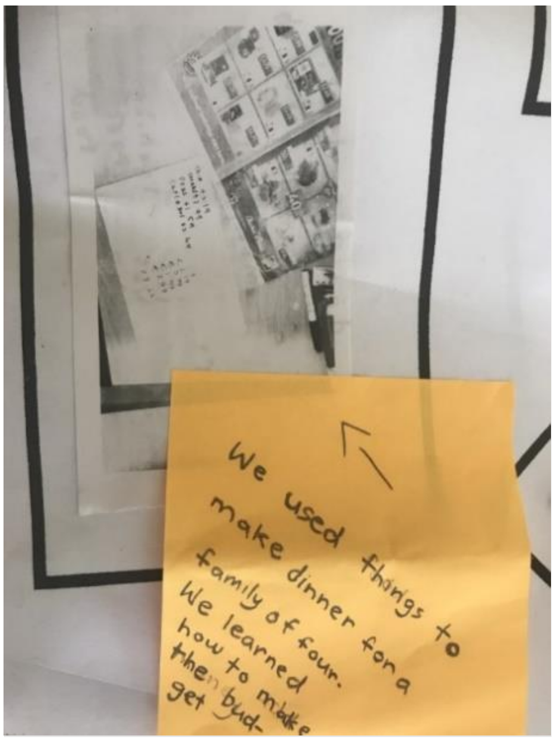
"... it was fun. The tiny bit of detective work"

Children universally favoured a range of more interactive learning opportunities. Many children across classes warmly recounted opportunities to explore mathematics in their environment: 'I remember the day we were down with the other class [mainstream class] and we were learning about shape. So, we had to go outside and look for shapes…and were taking photos of shapes outside to make a book on the tablet" [Class 4, draw and tell]. Children identified the affordances of actively engaging in meaningful activities in terms of enjoyment and understanding: "I find it [Data strand] easier to remember and it's like, it's more fun to learn than algebra because it's more hands-on work… Because we love sports, so we … asked everyone what their favourite sport was" [Class 3, strand ranking activity]. They also valued opportunities to engage in hands-on learning that included estimation and measurement: "... it was fun. The tiny bit of detective work" [Class 8, strand ranking activity]. Children also advocated for the use of maths games, highlighting the opportunities for enjoyment while learning using online maths games (image below) and in-class maths games: "you could do a game about the subject that you just learned. And I think that might engage people more in the learning of the subject" [Class 2, vox pop]. Such games and activities appeared central to why some children identified doing mathematics on the whiteboard as a favourite activity "'cause it's more interactive than books and more fun" [Class 5, focus group]. Children also endorsed the use of mathematics board games as a possible approach to learning mathematics: "…we found [maths board game name] fun and easy to play… games like these are interactive and it's also almost like you're playing at home and not even at school" [Class 7, focus group].



[Class 6, photovoice]

However, in some classes, children described more regular opportunities to actively engage in meaningful, learner-centred mathematics activities that spanned the mathematics curriculum. For example, children in class one described an open-ended supermarket catalogue activity that required them to work in pairs to respond to the challenge where "… you had 10 euro and you have to try find a dinner for family of four" [Class 1, photovoice (below)].

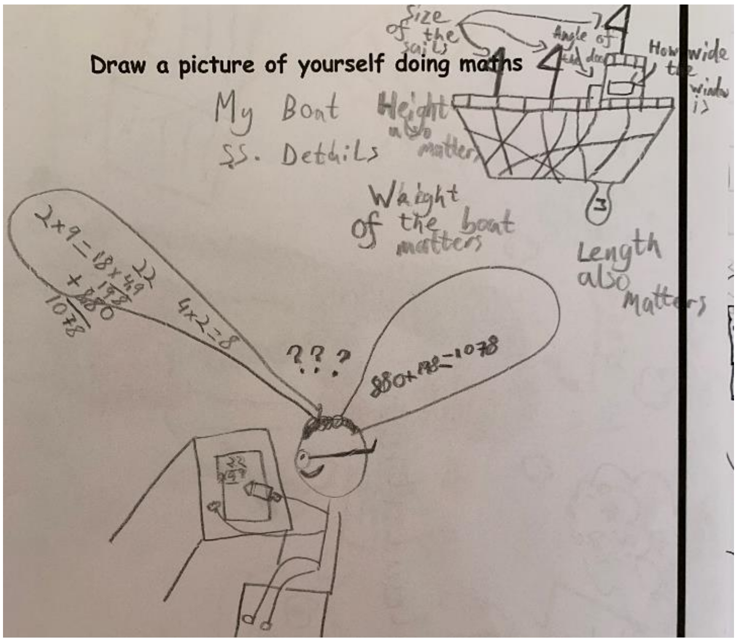


[Class 1, photovoice]

Children in class ten described a range of learner-led activities. For example, children "collected data to see what times do people go shopping at most…their shopping habits" [Class 10, draw and tell (image below)]

[Class 10]

These children also reported regarding the mathematics concepts required to complete a 'Viking longships' project: "the sails they have they must have a certain size so the wind could push it and also the weight of the boat should be like around 300 grams …and the door which I put in for detail. It has to have a certain angle…" [Class 10, draw and tell (below)].

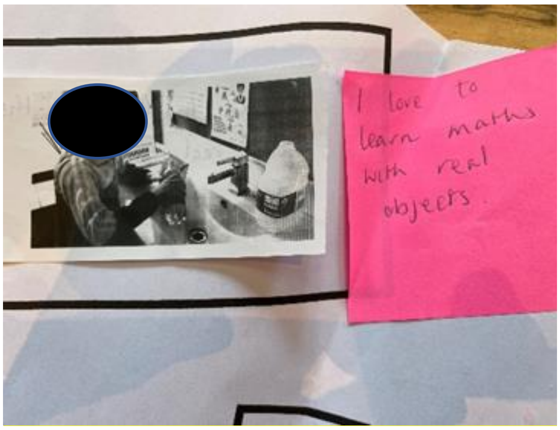


[Class 10, draw and tell]

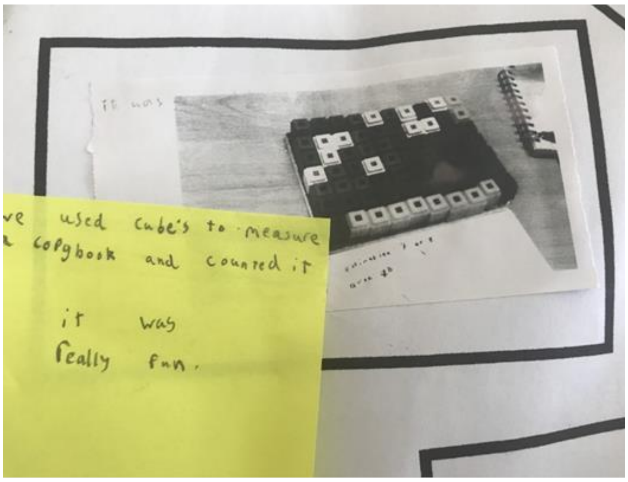
The children in classes that received regular exposure to meaningful mathematics activities tended to demonstrate positive emotions towards mathematics as well as an awareness of its relevance:

> “Maths so fun and it's useful…you need maths” [Class 1, photovoice].
>
> “It was hard to do because there was a lot of details, but it's fun to do. It's fun though. So sometimes hard can be fun” [Class 10, draw and tell].

All children valued opportunities to use *resources/materials* to aid their understanding of various mathematics concepts [Class 4, photovoice (below)]. For example, children described using blocks to model area [Class 1, photovoice (below)] and perimeter as “easy and quite cool” [Class 2, photovoice]. Equally, children agreed that opportunities to build and examine 3-D shapes supported their understandings, noting that “it’s easier to touch it and all and see how many edges it has” as opposed to “trying to picture it in my head and I’d sometimes get it wrong” [Class 3, draw and tell].



[Class 4, photovoice]



[Class 1, photovoice]

4.3.3 Desire for more variety

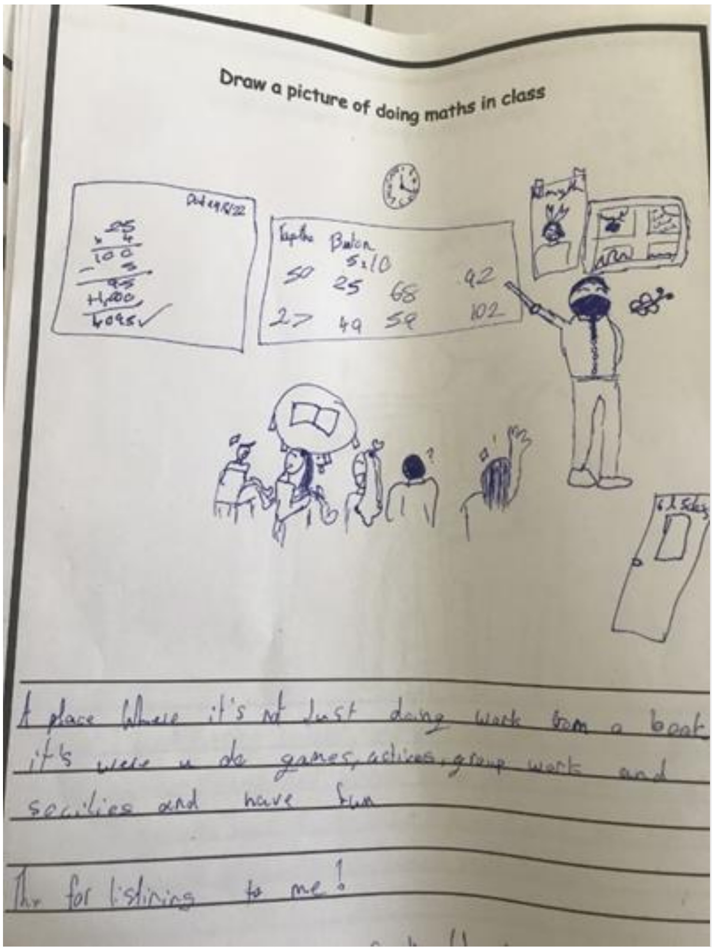
“...just working in your copies alone - just like never again - against the law - 5 million euro fine for any school that does it”

Across the data sources, children consistently communicated a desire for more variety: “I know there's sums [we did using Pizza menus] that were in the [names a textbook series], but it just makes it a lot more fun just looking at something different than the book” [Class 7, focus group]. In response to the request for recommendations for the Minister for Education, children who previously reported limited exposure to a variety of learning approaches addressed this by suggesting: "I think we need to do less of … constant like pages of maths" [Class 9, vox pop]. One child's suggestion reflects their level of disdain for the predominant approach they had experienced: "just working in your copies alone - just like never again - against the law - 5 million euro fine for any school that does it", justifying it by stating "I think it's just a complete waste if you're not connecting with the child to see how their brain is working" [Class 8, vox pop].

During the focus group, across all classes, children's requests and suggestions to incorporate more variety were very pragmatic and mature as can be seen in this excerpt from class five:

> Rolf: I'd like different types of maths … instead of just writing in a book, like going outside and going with the trundle wheel and that stuff
>
> Isha: And I'd like to do more quizzes. We don't do anything like that.
>
> Sadie: Yeah, they [quizzes] would make me want to work harder. Like, if I'm against another team, I'd try harder.
>
> Jim: It's just boring doing the same thing over and over again
>
> Isha: I just want to get different stuff
>
> Amie: Like one day you could do written activity and then one day you could do something outside and it'd be mixing [things] up
>
> Rolf: Maybe another day it could be up to the board. And another day you could do maths games.
>
> Amie: But we did do shapes on Monday. That was a good day.
>
> [Class 5, focus group]

Some children made recommendations regarding the context or concept within mathematics activities: "something that we find interesting and not something that no one really likes in the class or something that's going to be beneficial, that's going to stand us when we're older [Class 7, focus group]. Children repeatedly communicated a desire for a variety of engaging mathematics learning experiences (picture below). This included recommendations that "instead of doing a lot of books", teachers should "try to do more games, and projects…" [Class 2, vox pop]. Across all schools, children repeatedly called for access to a variety of learning experiences that included “more practical work… just a break from the books, like more iPads, more board games, still learning but doing it in a more fun way” [Class 9, vox pop].



[Class 9, draw and tell]

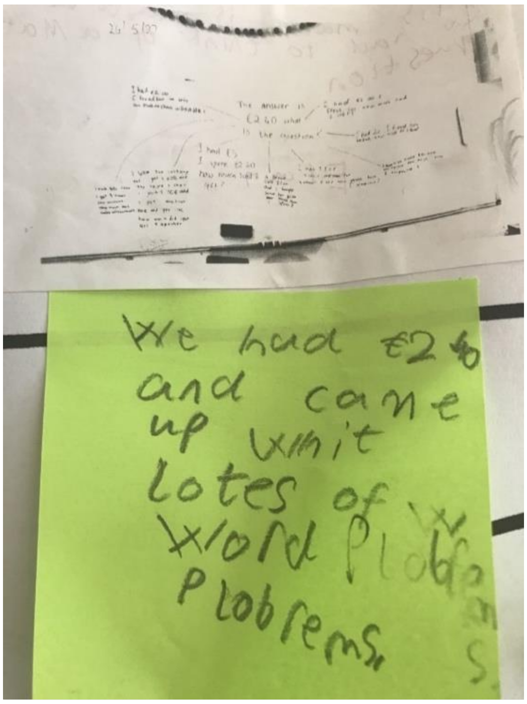
Children in one class acknowledged receiving more opportunities for active and meaningful mathematics learning in their earlier primary education. In a focus group, one child stated “it's kind of gone boring now… when we were younger, we used to … pretend you were in a shop and like go off with the money and ask for a certain amount of change back. But it's gone a lot different now …” [Class 7, focus group]. Another child from the same class questioned if teachers “currently see sixth class as too old for like small activities, like going outside, that they're a lot more drawn … to just do the work in the book” [Class 7, focus group]. These children challenged the perception that reform-based approaches are not relevant for them: “I think they should see that it's actually really fun. For every kid to get outside and even, from buying to activities even like… maths with PE” [Class 7, vox pop].

4.3.4 Problem solving

"I like them type where you have to think about it for a minute"

Problem solving was mentioned in various guises across the classes. In several classes, children spoke about activities that were mathematical exercises to provide practice in executing procedures rather than problem solving, in the mathematical sense. One child described it as "And so it's kind of it's like a revise. It's like revising to get back into your head so like in case you forgot" [Class 2, focus group]. For others problem solving evoked thoughts of decoding word problems "problem solving is like word problems, like sometimes you have to find out what they're saying" [Class 2, focus group]. Others, when asked what they think about problem solving, replied "confusion" [Class 6, focus group] and "I don't mind problem solving. I find it fun but it's not my favourite" [Class 8, strand ranking activity].

In contrast, however, were classes that reported experiences in problem posing and in solving open ended mathematical problems. As illustrated in the image below, one class spoke enthusiastically about posing mathematical problems themselves, with one child stating that the teacher provided the answer "The answer is, for example, two euro 50 cent and [we] have to guess a word problem" [Class 1, photovoice]. Such experiences were described as "more, more fun. …. you'd have more enthusiasm because …it's more exciting than just what is 25 cents plus two to your 25 cents" [Class 1, photovoice].



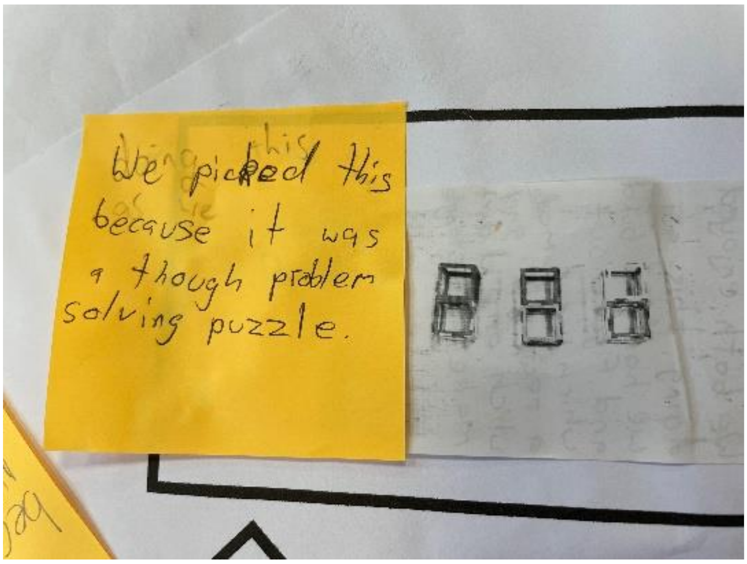
[Class 1, photovoice]

For some, problem solving was associated with number work "I like number work. I like all the problem solving and I just say enjoy trying to figure sums and all out" [Class 8, strand ranking activity] and "we always do the maths problem solving. On this one you get one cent and then every day for 31 days you will double it … I like that" [Class 9, photovoice]. For one group in class ten, they identified number as their favourite strand because "like doing just solving problems" [Class 10, strand ranking activity] and algebra as their second favourite "Everybody here agrees on algebra. Well, most people here like solving the problem, taking the time with it and trying to find out" [Class 10, strand ranking activity].

Reported positive experiences of problem solving were often tied to other classroom mathematical practices and characteristics of problems. For example, some children reported awareness of problems having *multiple different solution paths* "Like there's usually like two to three ways how to do something and some people do some other ways" [Class 7, focus group]. For others, problems selected for display on posters were problem solving puzzles that provided *challenge* (see image below). We can see in the following quote that the child enjoyed the problem, however, he also enjoyed *working with others* on the problem and he enjoyed the challenge "I picked this one, the ice cream cone, because it was challenging, and fun as well. We enjoyed it together. Well, I enjoyed it mostly because there was problem solving. And I like problem solving once I find it tough" [Class 3, photovoice]. This appreciation of challenge was evident in class eight in the following focus group conversation:

Interviewer	Do you like problem solving?
Cathal:	I like that it pushes you. Yeah.
Mai:	I like them type where you have to think about it for a minute.
Interviewer	Have you ever done any problem solving where you're looking at something and the answer is not obvious immediately?
Sian:	Yeah.
Interviewer	How does it make you feel?
Sian:	It makes me feel if like, if it takes over 10 minutes for me to figure out a single problem. Like it's a bit frustrating, but if it takes me like 5-10 minutes then I'm satisfied. And I like one brain worm.

[Class 8, focus group]



[Class 3, photovoice]

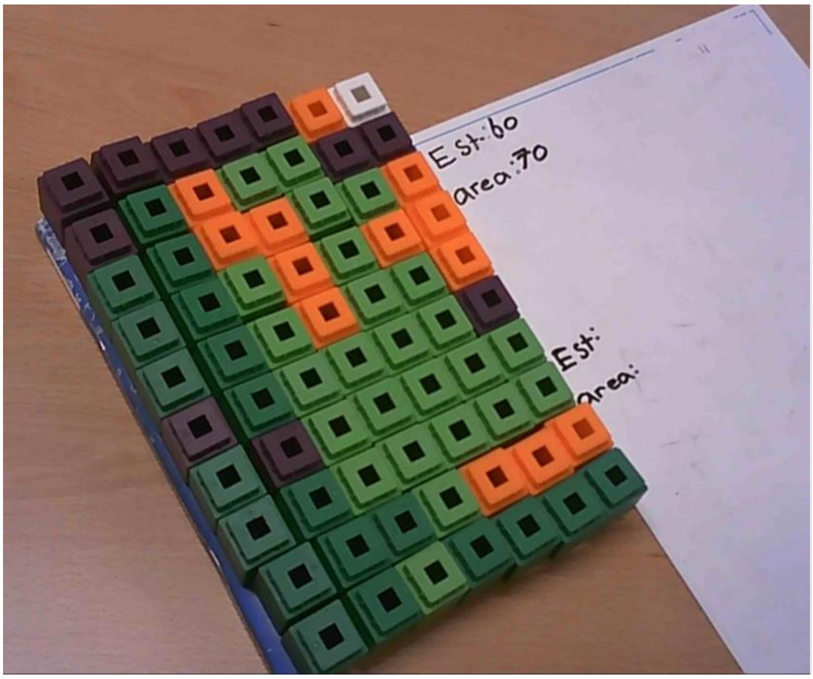
4.3.5 Right answers

Getting the “right answer” in mathematics emerged as a theme across five of the ten classes. This varied, however, from getting the “right answer” as being the goal in mathematics in four of these classes to the “right answer” not being important in one classroom, due in part to the nature of the mathematical activities in this particular class.

4.3.5.1 Focus on the right answer

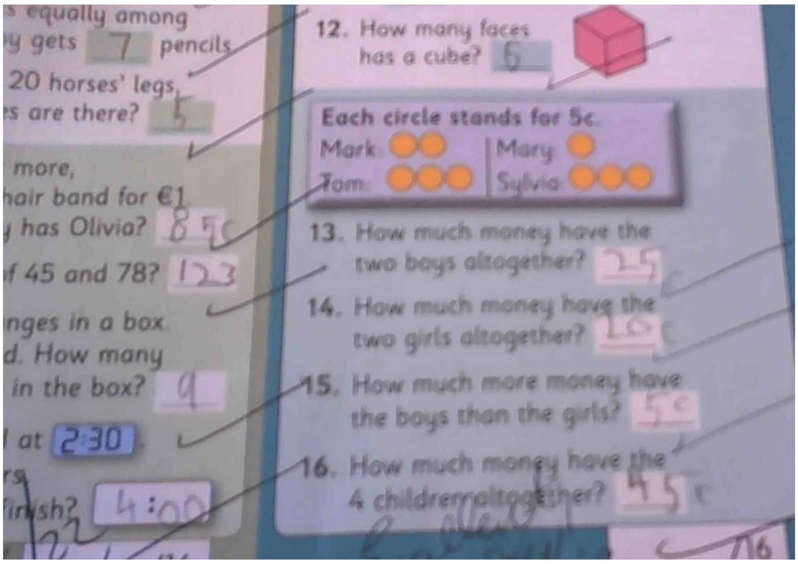
“Rub it out”

In four of these five classes, the data suggests that children viewed getting the “right answer” as important in mathematics, and in some instances, the sole goal in mathematics. For example, in class one when discussing estimation during the photovoice activity, three children viewed estimation as a helpful tool in a quest to get the “right answer”. One child viewed estimation as helping “you see if you were right or wrong” whilst another child stated that “estimation would be helpful because then you could get closer to figuring out how to get the answer correct” and so you know whether “you’re on the right track” [Class 1, photovoice presentation]. The image below shows a photograph taken by a child in class one whereby the child first wrote an estimation for the number of cubes and then wrote the “correct” answer.



[Class 1, photovoice]

During the draw and tell in class three, the difficulties a child experienced in learning the Area strand unit highlight the child's struggle to get the "right answers" and the importance of doing mathematics "properly": "I couldn't get the right answers. I kept getting the wrong ones. I guess I didn't understand them…. I can get the answer right now because I'm able to do it properly" [Class 3, photovoice presentation]. The image below details a "corrected" textbook in which there was only one possible "correct" answer. This image is taken from the children's photovoice activity in class three.



[Class 3, photovoice]

The importance of doing it properly and getting the answer right was also evident during the focus group in class six where one child described feeling "…so stressed because I am ready for teacher to say rub it out" and another child added "…there was actually a very good phrase down in the junior room – do it nice or do it twice" [Class 6, photovoice]. Feeling stressed as a result of not getting mathematics "right" was also evident during the focus group in class eight when discussing feelings about the use of workbooks in mathematics:

> [I feel] stressed. Anxious. Because, like, you might be stressed because of the right thing in your copy and you want to know if it's the right or wrong answer but that your copy never gets collected and then you are distressed. Or stressed.
>
> [Class 8, focus group]

During the draw and tell in the same classroom, the focus on getting the "right answer" was also evident. For example, a child explained that they liked a game-based learning platform because "you just press a button and see if you're right… so, if you if you're not good at something, and you use [names platform], that it'll give you some answers and one of those answers will be correct". This child then concluded that because answers were provided to you "you can work it out yourself and then you have no choice but to get it right" [Class 8, draw and tell]. The helpful nature of being provided with potential answers was reiterated during the photovoice activity in this classroom. One child outlined that "it's not as hard so you know, one of them [is right] and the rest are wrong". Again, the focus on being "correct" was emphasised by another child: "…if you don't get it correct, but you have a fair idea, you go for the closest one and you have a better chance [of getting the answer correct]" [Class 8, photovoice].

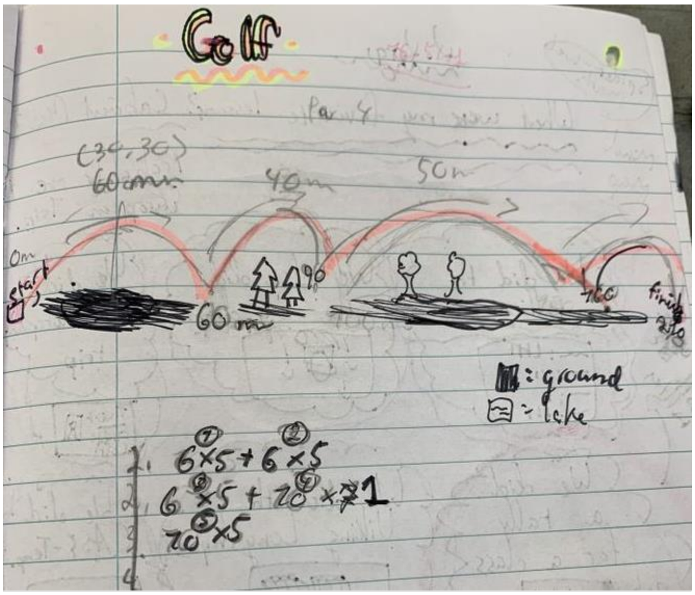
When getting the "right" answer emerged in the data, it typically represented traditional approaches to mathematics teaching and learning in which the focus is on getting the answer "correct" and only one "correct" solution exists.

4.3.5.2 Focus on multiple correct solutions

"... but then they might give a different answer. And you might be like, oh, yeah, maybe that's right"

In contrast to these four classes, the data suggests that rather than a focus on getting the "right" answer, in one of the classes (Class 10) the focus was instead on engaging in a cognitively challenging activity in which multiple correct solutions were possible. In this classroom, the children viewed challenging activities as enjoyable and fun. Further, they worked together in finding and negotiating multiple solutions, with an emphasis on the process. The images below demonstrate the process through which children worked during these cognitively challenging activities. For example, when speaking about groupwork during the focus group a child described the process of "cooperating with people" to discover solutions: "you're like talking [about] how to do it, and you might disagree on something, but then they might give a different answer. And you might be like, oh, yeah, maybe that's right" [Class 10, focus group]

[Class 10, focus group]



[Class 10, focus group]

Richer mathematical activities which were cognitively challenging; however, were evident in one class where the focus was on the process and multiple correct solutions. In this classroom, children worked together in a process of reasoning and negotiation to ascertain multiple correct solutions.

4.3.6 Speed

Data related to speed in mathematics was evident in seven out of the ten classes. In three of these classes, children referred to the importance of speed in mathematics or of working against a clock, whilst contrastingly, children in four of the classes were of the general view that speed is not important in mathematics.

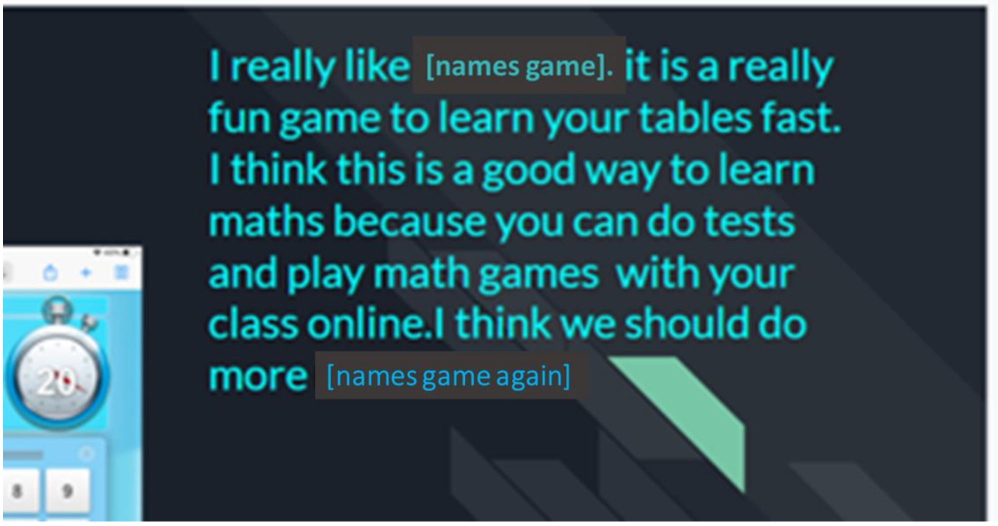
4.3.6.1 Focus on speed

"You kind of want to be quick because in the Drumcondra[1] , you only get 35 minutes for a good few questions"

In three of the seven classes that referred to speed in mathematics, the data suggests that children viewed speed as being important in mathematics. For example, during the photovoice activity in class six, a child enthused about using mathematics games on a mathematics website

[1] The Drumcondra Primary Mathematics Test is a set of curriculum-based standardised assessments of mathematics achievement for primary school pupils in Ireland

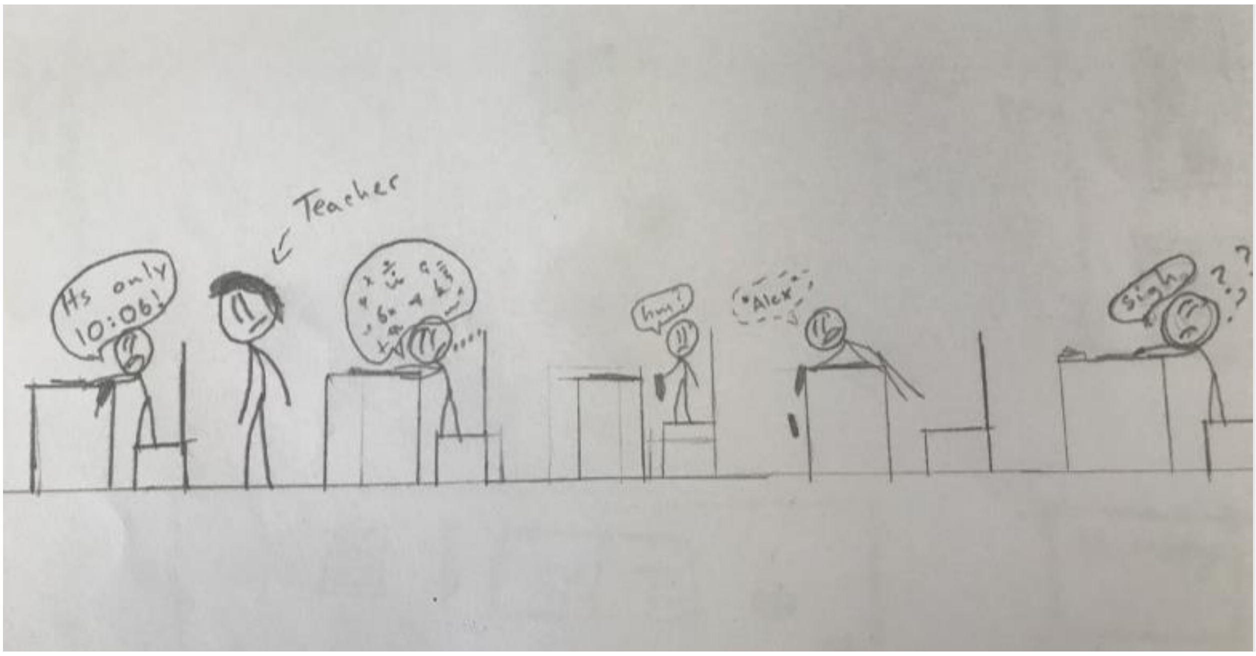
on an iPad. In particular, the child indicated that "it is a really fun game to learn your tables fast" [Class 6, photovoice] and that "you have to get it done as fast as you can" [Class 6, photovoice (below)]. Additionally, the child explained about doing tests on the website; playing games with the class online; getting points; and playing against the timer: "you get points for it. And whoever has the most points at the end when the timer runs out wins".



[Class 6, photovoice]

Similarly, working against an online clock in mathematics came up during the focus group in class nine. Referring to the online game, a child explained that you are playing against the clock and trying to achieve your personal best: "…you have to see what your personal best is and so let's say you are doing twelve you might get like thirty seconds". The researcher then asked "do you like the time pressure?" to which two children in the group nodded. One child said "yeah because then you have to think really fast" whilst another child said: "sometimes the teacher gives like just three seconds and it's like a test for everybody" [Class 9, focus group].

This data suggests that for these children, at least when related to computation or doing "tables", doing mathematics "fast" is rewarded, and arguably that this equates to being successful at mathematics [Class 9, draw and tell (below)]. Also, in class nine, a different child during the draw and tell discussed the "genius one" in the mathematics class. The child explained that the "genius one" is very good at mathematics and that he knows everything. Additionally, this child's conception of a mathematics genius is a child who knows mathematics that others do not know and one who works things out and shoots his hand up very fast: "when the teacher is asking questions, and no one knows, he's like, working it out on a page and then he'll like shoot his hand up very fast to answer the question" [Class 9, draw and tell].



[Class 9, draw and tell]

Relatedly, during the focus group in class seven, a child drew a correlation between testing and speed when speaking about studying for standardised tests: "…when you're studying for them [standardised tests], I think you should like do them slowly so you understand them better. And then close to the time you should like try to work them out faster and faster until the Drumcondra [standardised test]". Another child in this class also considered speed essential when doing standardised tests: "you kind of want to be quick because in the Drumcondra [standardised test] you only get 35 minutes for a good few questions. So, you need to be fast enough". A different child highlighted the importance of learning off "times tables" for timed tests: "when you only [have] 30 seconds, it's good to have a good understanding in your head as well as working out and for things like for times tables, there's no really like method, it's just you have to learn them off in your head" [Class 7, focus group].

In all three of these classes, the children emphasised the importance of speed in mathematics, and importantly, they view speed as being rewarded in mathematics, whether in online games, online tests, teacher activities, or standardised tests.

4.3.6.2 Focus on understanding / accuracy

"Easy slow easy go…it will make you see more details"

Contrastingly, in the other four classes in which speed was discussed, children expressed the view that understanding mathematics, and accuracy in mathematics, are more important than speed. For example, during the draw and tell in class one, a child was adamant that speed is not important in mathematics. When pressed, the child opined that taking your time allows you to see more details in mathematics:

Researcher**:**	So, do you think speed is important in maths?
Daisy:	No!
Researcher:	No. Why? You sound very strong about that. Why not?
Daisy:	Because easy, go easy. Easy, slow, easy…Easy slow easy go.
Researcher:	Okay, so you think if you take your time, what will that do?
Daisy:	It will make you [pause]....it will make you see more details

Similarly, when asked about speed during the draw and tell in class two, a child stated that mathematics does not have to be fast. The child stressed the importance of taking your time and getting it right, instead of rushing and getting it wrong: "You just take your time. Take your pace. Just try to get it right. Because if you're just going to be rushing, you probably will get most of them wrong" [Class 2, draw and tell]. Similar views relating to not rushing and accuracy were expressed during the focus group in class three. When asked about speed during problem solving, a child said: "…if you rush yourself too fast, you're probably gonna go wrong. But if you go slow enough or that you're probably gonna go right" [Class 3, focus group]. Another child in the group agreed with this:

> A lot of the time, if you rush it, you'll get literally half your answers wrong. Because if you go too quick, you're like, oh, good, I'm done but when the teacher calls it out, you're like, oh, wait, I didn't get any of those answers correct. So, you're never going to get the right answers when you're going too quickly.

Similar beliefs were articulated in the focus group data from class ten. For example, one child stressed the importance of accuracy and understanding over speed: "[being fast] doesn't really matter. The only really thing that matters is if like you get it right and you don't rush and you understand the piece" [Class 10, focus group]. Another child recommended "slow and steady" as an approach, to which the other children in the focus group agreed. Another child highlighted the inherent dangers associated with "rushing" in mathematics:

> If you rush something, your brain doesn't really think about what you're about to say. If you're rushing, you just write down random things. When you know the answer, if you rush something, you sometimes write down the wrong answer... sometimes you're thinking of the right answer when you're rushing but you're actually writing the wrong answer.

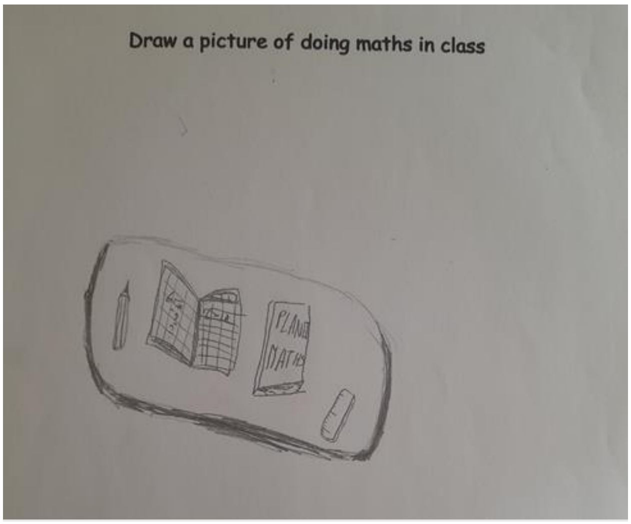
In conclusion, two strikingly contrasting approaches to mathematics are evident in the data relating to whether speed is important in mathematics. On the one hand, children in some classes viewed speed as important in mathematics, and believed that speed was rewarded in mathematics, particularly related to computation. Arguably, these children conceptualised being quick at mathematics as being successful in mathematics. On the other hand, children in some classes were strongly of the view that speed was not important in mathematics because it could hamper accuracy or correctness. At times, the data suggests that these children also had some sense of the importance of understanding the mathematics at issue, albeit this understanding related to getting the mathematics correct.

4.4 Theme 4: Children’s experiences of mathematics textbooks

4.4.1 Variation in textbook use

***“...what it usually looks like every time we do* maths”**

Across the data collection methods, children shared their insights about the mathematics textbook and its role in their mathematics learning. It became evident that within four of the classes, classroom practice was text-led, where the children spent the majority of mathematics class working from the textbook. In class eight, when asked to explain their drawing (drawing below), the child revealed “I'm just drawing what we normally do for maths every day okay? Most often we get our [names textbook series] out and we have a page and we do the sums on that page in our copy... and that's pretty much just it. I am pretty much drawing from my point of view what it usually looks like every time we do maths” [Class 8, draw and tell (below)].



[Class 8, draw and tell]

Children in the three classes where “it's all the textbook chapter. All week” [Class 9, focus group] demonstrated a strong association between the mathematics and the respective textbook. For example, in class nine, when asked to describe the mathematics in their drawing, the child responded by naming the textbook series they used. In the same class, another child described “proper maths” as “working with” [Class 9, draw and tell] the mathematics textbook.

In contrast, while in one class, children reported using the textbook very little, in another class, children did not use a mathematics textbook. Children in the remaining classes reported more variety, where the textbook was used alongside other approaches.

4.4.2 Children's reactions to mathematics textbooks

"more boring, boring bland book"

Mention of textbooks often triggered emotive responses from children. For example, in class three, when the researchers mentioned textbooks during the focus group, the children instinctively groaned. When asked to explain their reaction, one child responded "I'm not a fan of them, not a fan" [Class 3, focus group]. Similarly, in class four, one child reported "teacher just pops your math book in front of you and you're like 'Arrrggghhh'" [Class 4, photovoice]. It became clear that these children considered the textbook activities to be monotonous, referring to "You do the same thing because they just have pages and pages and pages of the same thing just in a row" [Class 9, focus group] and tedious "more boring, boring bland book" [Class 5, focus group]. While a child in class five vividly portrayed the repetitiveness of textbook work as "bang, bang, bang, and get it [done]" [Class 5, draw and tell], a child in class three described the effect of extensive text-led practice on their concentration "If I was doing them for a like a good while, like the words start jumping around the page" [Class 3, focus group]. The intensity of one child's dislike for the textbook was reflected in his evaluation "I would rate the maths book at 2.5 out of 10" [Class 9, focus group].

In contrast, a few children across classes reported less disdain for the textbook. During the focus group, children in class three agreed that they were content to use the textbook "every now and again" but would not "like to do it the whole time". Another peer's indifference to the textbook "The book doesn't bother me" was met by the justification "Because you can do everything in it!" [Class 3, focus group].

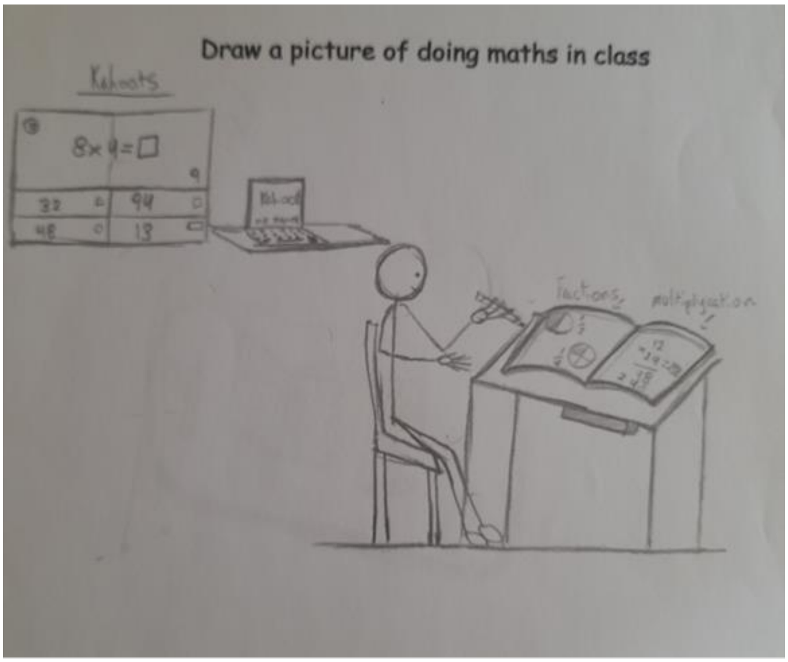
4.4.3 Children's critique of textbooks

"it's off-putting to think you have 200 more pages to do"

During the focus group, children in four classes were extremely critical of the structure of various textbook series. In one class, children agreed that textbooks should be "smaller…because there's like 200 and something pages in…it's off-putting to think you have

200 more pages to do” [Class 5, focus group]. There was agreement that textbooks generally failed to revise relevant concepts prior to introducing new content “the book kind of goes off what you're supposed to know at that time, but then we haven't learned it.” [Class 8, focus group]. They were also dissatisfied regarding the lack of explanations provided in some cases “It's more so like ‘Okay, here's the work’" [Class 2, focus group] or the quality of those given “.... It's just, it's I don't always get it… they don't always explain them the way that I understand” [Class 2, draw and tell]. It is interesting that these children perceived that the textbook should provide these supports rather than their teacher.

In one class, children reported using technology (illustrated in the drawing below) “to correct … we actually have this website. So, you don't have to go through the teacher calling them out and correcting them” [Class 8, draw and tell]. However, some children found the approach unsupportive: “the thing says it's wrong. So, you might doubt yourself” [Class 8, focus group].



[Class 8, draw and tell]

Some children believed that the textbook required them “to learn like little goblets of information and memorizing” when engaging with the textbook and were dissatisfied with limited opportunities for revision in some textbook series compared to others “they think you've like memorized and know it. And they don't like bring it up until the end of the book” [Class 2, focus group]. These children reported preferring textbook series that facilitated repetition and regular revision of concepts, stating "[name of textbook series] particularly understands children. They know how it feels to not know this. So, try and help". They appreciated regular opportunities to revise concepts as "you could forget it if you like don't do [it] often" or may "need more time to learn" [Class 2, focus group].

During the strand sort activity, one group of children revealed that another reason for their dislike for using the textbook relative to other approaches was the associated lack of opportunities for interaction with peers. Their justification for identifying the number strand as their least favourite was simple "We do more in the book. So, you don't get to work as much together for number" [Class 3, strand ranking activity]. Similarly, a child in class five believed that textbooks should include "more class activities like ones you can do, like with your friends .... like work together" [Class 5, focus group]. In the focus group, children highlighted that the textbooks provided a limited learning experiences relative to alternative approaches such as hands on approaches, "things like 3D shapes, I'd rather feel them", and opportunities to research shapes in the world by searching online [Class 3, focus group].

Across four classes, children spoke of their frustration at having to write both questions and answers "all out into our copy" [Class 7, focus group]. These children communicated a clear preference for whiteboards as an alternative. Reasons varied from "it's much funner" [Class 6, photovoice], to "you can rub it out easily" [Class 6, photovoice] and "you can do it [rough work] beside" [Class 7, draw and tell].

Despite identifying various issues with mathematics textbooks, many children believed it has a place in their learning, describing it as "useful" [Class 9, focus group] and acknowledged the "educational and interesting stuff" [Class 9, focus group] in the textbook series they used. Children also recognised that textbooks facilitated revision "if you haven't done it in a while, I kind of like taking out the book, and just being able to do a few sums… Just your revision basically, going over things that you've already done" [Class 3, focus group]. However, children objected to the excessive use of the mathematics textbook.

4.4.4 Children’s thirst for mathematics experiences beyond the textbook

“..constantly in a book just makes me frustrated”

When considering advice for the Minister for Education during the vox pop, classes where the textbook was the predominant approach, consistently craved a balance between textbook use and other more interactive approaches. The following excerpt sums up children’s desires in this regard:

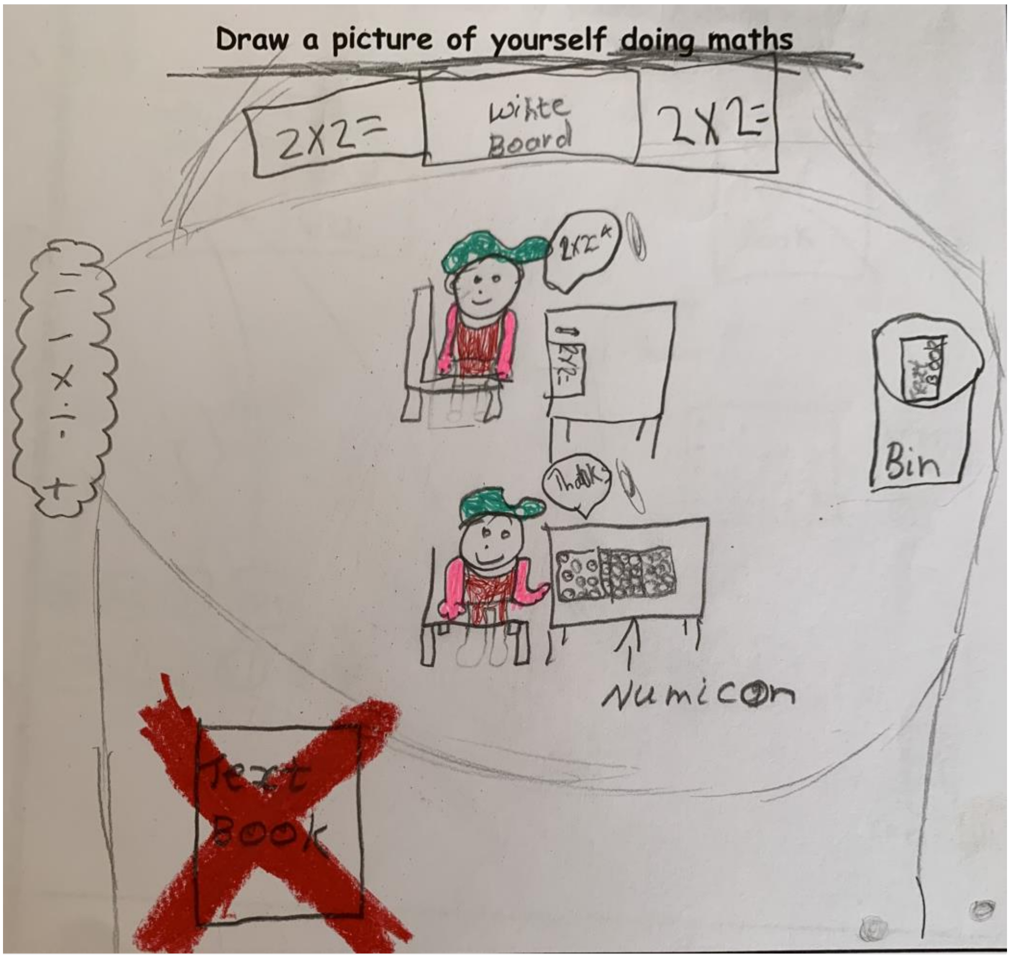
> I find a lot of kids get a lot more interested in maths because of the games and the iPads and new apps and all the new interesting stuff like games and socializing and being able to talk to your friends about maths and stuff. I find it lots more interesting, and that would make me want to do much more than just constantly in a book because constantly in a book just makes me frustrated [Class 9, vox pop].

These children tended to have low expectations, where some only requested alternative approaches “at least once a week” [Class 9, vox pop]. There is much potential to far exceed the modest alterations suggested. Yearnings for more variation of learning experiences during mathematics is explored fully in the subtheme *Desire for more variety* within the theme *Children’s experiences of mathematics.*

4.4.5 Children’s experiences of textbook-free mathematics learning

“... we weren't having to like just stick to pages”

It is interesting to contrast the above views with those of class ten. These children had previously used mathematics textbooks but had not used textbooks during mathematics class during their current school year. Instead, they used copies to record their learning “you have everything that you learned in your copy books, and if you forget anything you can just look at your copy book” [Class 10, vox pop]. These children did not consider textbooks necessary, a preference reflected in many of their drawings, where the textbook was crossed out (see drawing below). When asked to explain, one child highlighted that they had placed the textbook in ‘the bin’, explaining “in the new curriculum, there's no like doing everything out of the textbook…and I like that” [Class 10, draw and tell]. The focus group discussion confirmed the level of agreement, as children concluded “I prefer not using any textbooks”. Reasons included a sense of increased flexibility “we weren't having to like just stick to pages” [Class 10, draw and tell]. Children also contrasted the quality of their learning experience "I think learning maths is better without like the textbooks" [Class 10, vox pop] and increased ownership over their learning "you can do it on a page. You could design it, you could write it in your copy. Like examples like that" [Class 10, vox pop].



[Class 10, draw and tell]

4.5 Theme 5: Children's experiences of context in mathematics

4.5.1 Appreciate and value the role of context in mathematics

"...how much meal to buy cause milking cows need lots of meal"

Many children demonstrated a keen awareness of the role of context in mathematics. They drew from the role of mathematics in their pastimes and in their future professional lives:

> "...shapes are most important for me because I use them every day. … I draw a lot, and I build stuff up with shapes all the time" [Class 9, strand ranking activity]

> "...if you're like if you're ever going to be like a bank accountant, or something, you need to know algebra [Class 8, strand ranking activity]"

> "...if you wanted to be a builder, you might only need some maths like, how to add up how many litres of cement are in the cement bucket" [Class 4, strand ranking activity].

Children from farming communities readily identified how "you need to multiply and subtract to find out how much a cow is", "need maths to find how much profit you'd make" and "how much meal to buy cause milking cows need lots of meal" [Class 5, focus group]. The role of data in supporting active citizenry, at a local and national level, was evident across several classes, "we need data .. like in voting for the new President or in school. Or let's just say for a student counsel you could go around to the school and ask for votes" [Class 9, strand ranking activity], "Keep data because it helps to understand things" [Class 9, vox pop] and "Data is important. Like if we ever wanted to ... count the voting, data is important for making sure everyone gets their say…" [Class 3, strand ranking activity].

The value children place on specific mathematics strands was, for the most part, motivated by the real-world contexts that they associated with the mathematics strands. Consequently, in the strand ranking activity, many ranked the strands highest that had most real-world relevance for them. The following small group conversation, in class one, provides some insights into how children valued context.

Freya	Number ... all the time we need them for most things. Like money, when you're exchanging
Samuel	Yeah, because of currencies and jobs. If you're a cashier … you can just calculate. Ya, you need maths, money for jobs or for paying
Tomas	and you need [it for] measures
Stasia	Measurement is quite important ...it tells people how tall people are, long things are, wide. Measurement like with the table, books and copies. I don't think Shape and Space is important. Well, it is important if you're going to be a construction worker but I'm not going to be a construction worker.
Freya	Data and chance is quite important ’cause you need it to tally stuff, to mark, if you're doing a survey.

Similarly, much of the advice for the Minister of Education, given in the vox pop, was motivated by the value children attributed to studying specific strand areas of mathematics. In the following excerpts, children’s perceived functional role of mathematics is evident:

> You should keep more practical things that could help people like later with jobs and stuff like measurement like Pythagoras theorem and stuff like that. Stuff that can help you measure with jobs like being a builder, you need to know stuff you need to know angles. I can't really think of anything that I would drop. I mean, learning shapes isn't exactly way too handy. But like I wouldn't say get rid of it completely. You might need to know some shapes [Class 8, vox pop]

> I feel like we should learn more things about foreign currencies and different measurements in different countries as well because a lot of recipes and stuff online and in books is in like cups and other ways of measuring things. So, I feel like we should probably be taught stuff like that. [Class 8, vox pop]

> I think there should be more measurement ... because it’s probably one of the things that’s mostly used in real life. Otherwise, the roof would probably have fallen in by now, if we didn’t have measuring. [Class 3, vox pop]

In contrast, in several classes, children failed to see the relevance of certain areas of mathematics. This deficiency makes a compelling argument for greater use of contexts when teaching these topics. This was especially evident with reference to Algebra “I think algebra isn’t that important …. I just don’t think you use it in life that much” and “I don’t think there’ll ever be a point in my life where I’ll come across anything to do with algebra” [Class 3, strand ranking activity]. Specific strand units were in for critique such as “Square numbers and triangle numbers. Sure, like what are we going to use them for?” [Class 3, strand ranking activity], “Why did we learn about the circle? Like, you're never going to need to know it” [Class 5, strand ranking activity] and “Shape and space is very bad, just to tell you… because it's so boring and there's no new shapes. Shapes are the same thing” [Class 5, focus group].

Children were able to identify situations where they used contexts to support them in understanding mathematics, “Whenever it has to do with numbers, I think of darts to help me, because of how many numbers there are on the dartboard. It’s helps me with all the trebles and doubles, it helps me to get the answer fast” [Class 3, focus group] and “[In Minecraft], I learned the whole like you know, three by two or three by three, … I learned three by three equals nine on Minecraft” [Class 6, strand ranking activity].

4.5.2 Desire to experience more meaningful and context-driven mathematics

“I love the challenge, the way you have to build something when you have a budget”

There was a strong mandate, evident across classes, for more meaningful and context-driven mathematics to be used in schools. This was expressed through their critique of their experience of mathematics as a series of context-free repetitive activities:

> “There's [name of textbook series], there's sums, the tables, then there are shapes like circles, cubes, rectangles, then you have a maths copybook. Then you have a mental maths where we do our homework and stuff” [Class 7, draw and tell].

Such descriptions presented a sharp contrast to their identification of their favourite mathematics experiences, the majority of which leveraged real-world contexts. For example, children spoke excitedly of times when “we were actually planning on a piece of paper where we had our own dream house and we're doing the areas and we googled for different things and searched measuring square meters” [Class 3, focus group].

The mathematical contexts used in class ten were also spoken of with great excitement. Contexts were used to situate the mathematical instruction and appeared effective in demonstrating the real-world relevance of mathematics. For example, across many different activities shared using photovoice, where children spoke very enthusiastically about a building activity and managing the cost of building structures to stay within budget

> "I love the challenge, the way you have to build something when you have a budget"
> "You have to try keep to the budget, not go over it. So, it's like a challenge if you go over you start again" [Class 10, photovoice].

Another child spoke of budgeting supermarket shopping "like when we were doing the shop, we had a budget for how much to pay …and we had to try and find a percentage. That's because there's lots of tax. That's because there's a lot of budgets in life." [Class 10, focus group]. Other contexts drew on children's design skills and imagination in the design of spaces and structures requiring the application of different mathematical skills and concepts in order to meet the design briefs. One child described the golf course design activity "it was really enjoyable. I really liked it because you have to use like your imagination to make a golf ball. And then you have to think about the cost calculations. So, you could either use a two club, a four club, a six, an eight or ten Club. And the strengths were half, one, three, five and seven. I enjoyed it ... we were used to like, open a textbook. And now you like use your imagination and make your own things" [Class 10, draw and tell]. When speaking of these activities, children spoke of the important role that mathematics played in these activities and appeared to have developed a keen appreciation for the role of mathematics in everyday life.

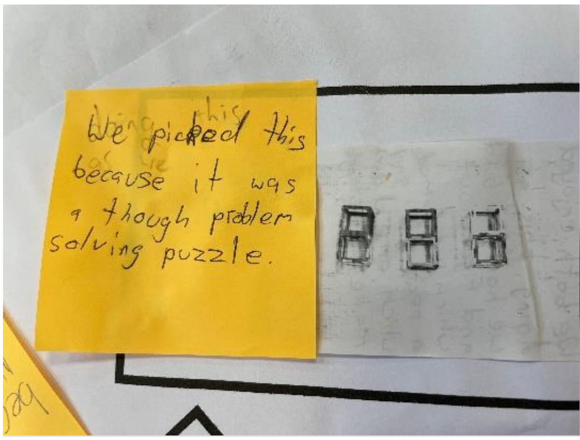
4.6 Theme 6: Children’s experiences of challenge in mathematics

4.6.1 Welcome and enjoy challenging mathematics activities

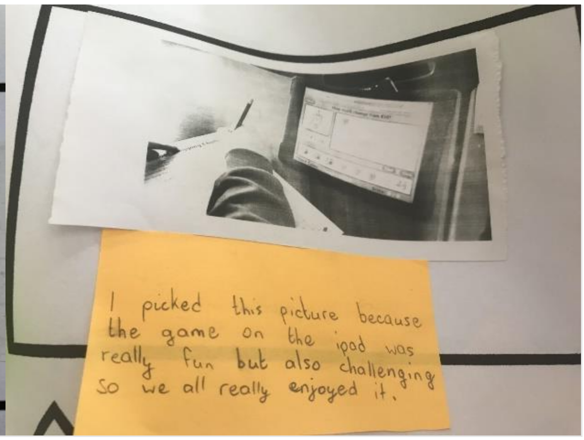
“You get to see what you know. Then I’m able to work on what I don’t know”

Many children welcomed challenge in mathematics. They spoke about being presented with activities that required them to “think hard” [Class 3, photovoice], “think about how to figure it out” [Class 1, photovoice] and identified their favourite activities as those that “made me think” [Class 1, draw and tell]. They recognised the opportunity to learn arising from engaging with challenging activities stating, “a lot of the time I learn more from it” and “You get to see what you know. Then I’m able to work on what I don’t know” [Class 8, draw and tell]. For a small number of children, it appeared that the challenge mathematics provided was an important characteristic and the reason they liked mathematics was because of the challenge it presented. When asked how he felt about maths, one child responded “Oh I like it a lot. It’s the challenge, it’s challenging” and another in the same class stated “I like in maths, I like a new challenge … I find them enjoyable when there’s something new to learn in maths … I find them like fun and a bit of a challenge” [Class 7, draw and tell].

Some activities displayed in photovoice posters were selected based on the challenge presented and were chosen because “it was fun and it was challenging” [Class 1, photovoice]. The first image below also revealed the value children placed on challenge. The second image is from a photovoice poster of a maths game. During the presentation of the poster the child explained “I picked this picture because it shows a person playing on the iPad. And it was fun, but it was also really challenging because you had to work it out on paper” [Class 9, photovoice].

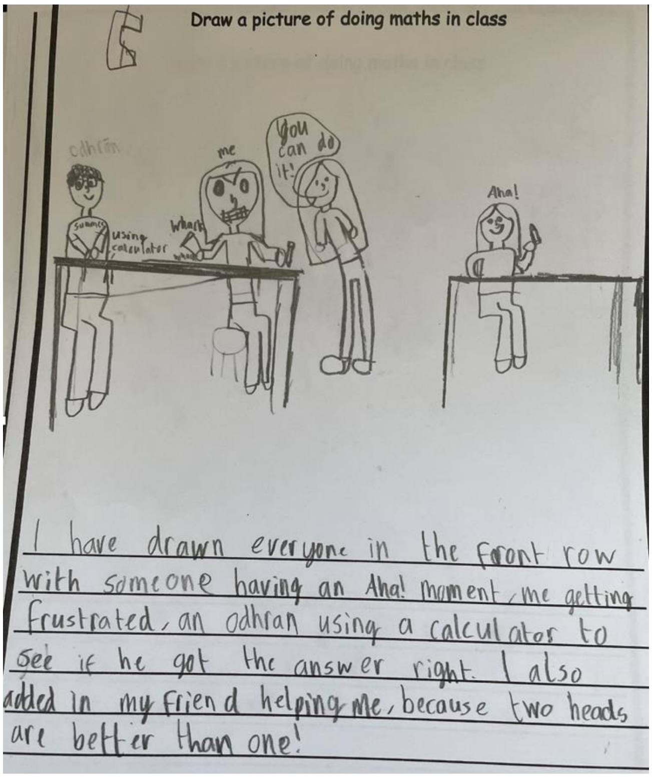


[Class 3, photovoice]



[Class 9, photovoice]

They spoke of the enjoyment solving problems “sometimes maths can be really challenging, and I really enjoy that” [Class 8, draw and tell]. They referred to the feeling of achievement and success experienced when they completed challenging activities. One group when sharing their photovoice poster stated “We like a challenge. When it’s challenging, it can be so annoying but then when you actually get it… it makes, it makes getting it feel so much better! [Class 5, photovoice]. The sense of achievement was also articulated by a child in an ASD class who, when recounting the challenges, he experienced when trying to understand digital time, stated “I feel lost sometimes, but when I finally have it done, I feel very proud of myself” [Class 4, photovoice]. Children in class two, in particular, referred frequently to ‘aha moments’ when they solved challenging activities, as described in the drawing below.



[Class 2, photovoice]

4.6.2 Value success and knowing when to expect a challenging activity

“I like when it’s a bit hard level and easy. Like they're the medium level so you can challenge your brain, but you can do it”

At the same time, children didn’t want every activity to be challenging as evident in their statements that they “like a little bit of hard” and “I like sometimes a couple of hard challenges”

[Class 5, focus group]. Children wanted challenges to be within their reach "I like when it's challenging but at the end, I just get it" [Class 3, strand ranking activity] and "I like when it's a bit hard level and easy. Like they're the medium level so you can challenge your brain, but you can do it" [Class 2, focus group].

An important caveat for many children, relating to challenging mathematical activities, centred on knowing when to expect challenging activities. Children appreciated knowing, in advance, whether an activity would be challenging. Many of these conversations were closely tied to the use of textbooks and workbooks. Children in two schools stated their preference for textbooks that presented a series of problems that increased in complexity. When describing her drawing, one child stated "In my drawing I'm doing [names a textbook series], we do that for homework. I like it because it's fun, but it is challenging as well. It has like 16 questions and then the last four questions are harder" [Class 10, draw and tell]. In another class [Class 2] during the focus group conversation children discuss their experience of challenging activities presented in different work/textbook series.

Zach: So, our teacher makes these little tiny maths books. They're what she knows we can do. There was like levels one to five. I'm on my second one. And that's for me, like my teacher knows, like where I'm at, cuz like I've done the first one. So, I go into the second one. And I find that it's more harder, but but I can still do it.

Rose: But [names a textbook series]. They don't … they don't even care that you can do it. They're just like, you can do this. Go do it.

Elisse: Yeah. I just feel like ... Sorry, the maker whoever like made all the questions in [names the same textbook series], I don't think they have any experience with kids at all. Because it's like, they expect you to know everything. They don't even like … at the start of the book, they literally just throw hard stuff at you. It's like they think that "oh, you're older, it's just gonna magically pop into your head".

Daniel: In [name a different workbook series], on the first page of the book, it's easier. But as you go along, as you like move on, it gradually gets hard [I like that]

[Class 2, focus group]

Conversely, children did not appreciate underchallenging mathematics stating "I don't really enjoy it as much when it's not challenging" [Class 8, draw and tell] and "I just I don't know why I just don't like when things are quite easy, because then it just feels like you can just do it like with your eyes closed" [Class 10, focus group]. They were critical of games that were not challenging as they can "get kind of boring and a little too easy" [Class 6, vox pop]. In focus groups, others spoke of liking online games with increasing levels of challenge and situations where "the games get harder" [Class 2, focus group]. In particular, they expressed their distaste for repetition, for "doing the same thing over and over again" [Class 5, focus group]. This was very well captured by one child who stated "I like it when it when it challenges me, I don't like it when it's easy and you have to repeat it over and over again. I prefer [it] when it's more of like a challenge and you have to like do more work on stuff" [Class 7, focus group]. They frequently referred to the monotony of completing exercises relating to number operations which "just gets boring because it's just very repetitive" [Class 7, focus group]. Shape and Space was also identified across several classes as presenting a lack of challenge with some children recommending to the Minister of Education that future curricula:

> "shouldn't have that much shape because we learn shapes in like, in our old classes" [Class 1, vox pop]
>
> "there's no new shapes, it should be taught up to third" [Class 5, vox pop]
>
> "...shape and space should be removed from sixth class because you've been learning shapes your whole life and there not much new shapes that you're gonna learn" [Class 5, vox pop].

4.6.3 Experience of cognitively challenging activities in one class

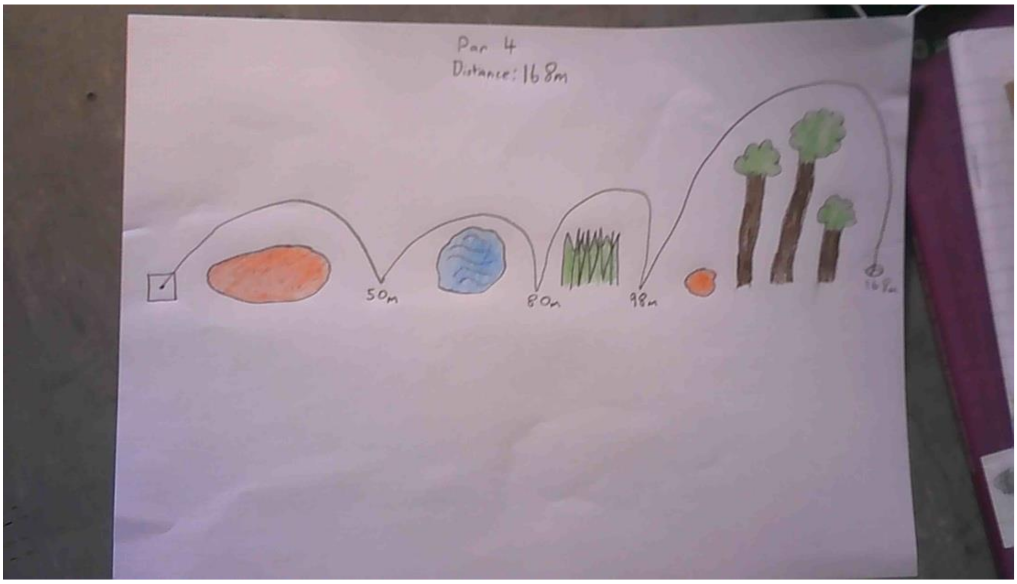
"You don't rush and you understand the maths"

Children in class ten have been engaging with cognitively challenging activities for the entire school year and shared valuable insights into their experiences. They shared photographs of cognitively challenging activities and also spoke with excitement about how much fun they had doing these activities. Analysis of their conversations suggests that they equated 'challenge' with 'fun' as both terms appeared together frequently in their discourse. For example, when discussing cognitively challenging activities in the focus group one child stated "they're fun and at the same time they're challenging. And like one time we did some, and lots of people liked it, but at the same time, it was challenging. So, it took us a long time. But at the same time, it was really fun like our trading. It was really fun. But at the same time, we were trying to think 'what was a good deal' and 'what was a bad deal'" [Class 10, focus group].

Evident from the above quote, and from other data, is that children noted, without judgement, that cognitively challenging activities take a long time to complete. They showed an awareness that "Slow and steady wins the race" and emphasised the importance that "you don't rush and you understand the maths" stating "if you rush something you your brain doesn't really think about what you're about to say. If you're rushing, you just write down random things." [Class 10, focus group].

Maths talk appears to be a central pedagogical practice that supported children when completing the cognitively challenging activities and it also contributed to the fun and engagement reported. From a mathematical perspective, one structural feature of the cognitively challenging activities shared by children is that they had multiple possible correct solutions. This open-ended nature of the activities supported children in the use of multiple solution strategies and approaches when tackling the activities. It also sparked an interest from children in sharing and examining the solutions reached by others.

The photograph below shows one of the possible correct solutions a child shared where the activity was to design a golf course and use their mathematical skills to identify the trajectory of a golf ball when considering using selected golfclubs, par and a series of shots.



[Class 10, photovoice]

4.7 Theme 7: Children's experiences of assessment

Although not asked specifically about assessment, assessment practices, in particular, strategies that are used in class; testing, and children's responses to tests, emerged as a theme across six of the ten classes. First, children's affective responses to testing are outlined, and then strategies that children identified as useful are discussed. Finally, children's recommendations for mathematics, as they pertain to assessment are presented.

4.7.1 Affective response

"...my stomach turned when I got called"

Although not asked specifically about testing, children in four classes detailed their affective response to testing. During the focus group in class six, a child described the frustration experienced when attempting to do your best on a test: "it's kind of frustrating if you don't get it. Like if you don't get the question or say you don't know what it means or anything. And you want to try your best, it can be wild frustrating" [Class 6, focus group]. Similarly, in class four a child described finding an end of year mathematics test "really, really hard" and "really, really confusing". This child explained the confusion, anger, and frustration involved: "I felt very confused and a little bit angry because it's like that one Rubik's cube you can't solve" [Class 4, focus group]. Interestingly, when later asked what makes him feel proud in mathematics, the same child responded that finishing a test makes him feel "very proud" [Class 4, photovoice].

Although not related to formal testing, and instead to in-class teacher questioning during mathematics class, during the focus group in class two, a child referred to how his "stomach turned" [Class 2, focus group] when being asked a question. When asked whether this happens in other places, he confirmed that it just happens in mathematics class. All of the other children in the focus group confirmed that this experience is exclusive to mathematics class:

Perry:	Like I got a ... my stomach turned when I got called because.... And I was like, oh, I don't know how to do this because I was distracted. Yeah. And now I just wrote in an answer. And then she [the teacher] was like, Okay….
Researcher:	Sometimes does your stomach turn… Does maths do that to you? Or does that happen in other places?

Perry: Maths.
All: Maths

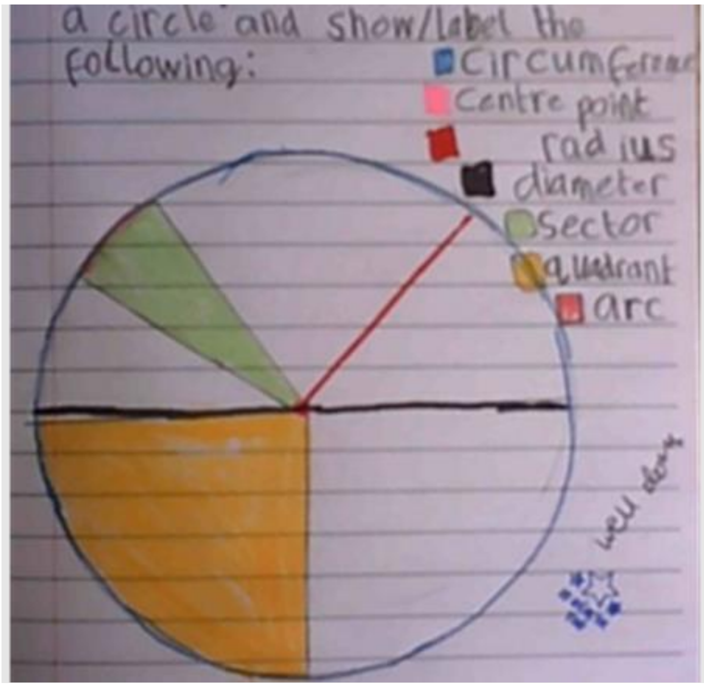
In contrast to these affective responses, a positive disposition towards mathematics tests including how tests can reward hard work, in addition to providing feedback to children and teachers, was evident in a child's explanation of their drawing in class seven:

Madison: [If] We try our hardest we will do well [on the test].
Researcher: Do you like testing?
Madison: Yeah, sort of…
Researcher: Yeah. Why do you like tests?
Madison: They show us how well we did and how much, and they show teachers how much we care about doing maths.

4.7.2 Useful strategies

"if you're like green, you're good. Yellow, you're ok; red, you need more work"

Only children from one class [Class 3] identified assessment strategies that they found useful during mathematics class. During the focus group, these children identified their mathematics journals as being "useful" and that "they help us a lot" because it enabled the children to "look back on anything" they had already done in mathematics. Examples provided by the children include information about the radius of a circle; fractions; a percentage wall; multiples; prime and composite numbers. An example from one of the children's mathematics journals is provided below. Whilst these mathematics journals could be viewed as an aid for children whilst engaging in mathematics activities, they also represent a log of children's learning and so can be viewed as a portfolio of children's mathematics learning. Further, the children reported using these journals as a form of self-assessment: "we don't have to ask [the teacher] every single time, we just need to go to the journal to check it out". In relation to the "learning goal" at the top of the page in the mathematics journal, one child explained that it represents "what we want to try and achieve" whilst another described it as "what we're doing" [Class 3, focus group].



[Class 3]

These children also identified a “traffic light” system as being a useful assessment strategy in mathematics class. The children use green, yellow, or red to indicate their level of understating to the teacher: “if you’re like green, you’re good. Yellow, you’re ok; red, you need more work”. Another child explained: “We just decide, do we need more practice, or are we alright? Or no, we don’t think we know”. As well as being a form of self-assessment, the children identified the benefits of this system for the teacher: “I think it’s better for the teacher as well because she knows if she goes through them, she knows what people want to work on, and what they think they’re better at, and what they’re weaker at” [Class 3, focus group].

Contrastingly, during the focus group in class seven, the children described a formal type of assessment on Fridays which they completed in a “test copy”. These Friday tests appear to be stand-alone assessments in that opportunities did not exist for children to review or consult these tests after they were completed or corrected:

Researcher: And would you go back and look at those tests?

Raymond: Maybe at the end of the year, we only get our test copy to do the Friday test on that day. And we hand them up to the teacher then and then she gives it to us the next day. And then we can look back when just before the test starts and see how we did.

4.7.3 Recommendations from Children

"…connecting with the child to like, see how their brain is working"

As part of the research, children were invited to make recommendations to the Minister for Education regarding ways in which mathematical experiences could be improved for children. Assessment featured in some of these recommendations including the need for teachers to "connect" with children's current understanding of mathematics. In class eight, a child described the futility of teaching mathematics if teachers do not ascertain children's understanding: "I think it's just a complete waste if you [the teacher] are not connecting with the child to like, see how their brain is working" including times where the child does not "raise their hand" [Class 8, vox pop]. In the same classroom, a different child explained how shyness and a lack of understanding can result in stress, boredom, and frustration:

> Well, I feel like if you don't know something and maybe you're a bit shy to call it out it's stressful. And it's boring because, you're just kind of, inside your head you're just kind of thinking what could it be? What could it be but you're not really getting anywhere because you don't know stuff. So that's boring. You can also get frustrating like I don't know what it is, and I have to the sums in order to get my lunch. Aaaggghhh [Class 8, focus group]

This desire for teachers to be able to identify and understand the mathematics with which children struggle, and the mathematics which children already understand was also evident in class six: "sometimes students are explaining what they're struggling with. Because sometimes this happens – I say 'teacher, I need help' and then they [the teacher] just start teaching me this random thing that I already know" [Class 6, focus group].

Relatedly a child in class two, described situations in mathematics class when questions are in "super hard mode", whereby the teacher conflates a child's lack of understanding with that child not listening: "and then you don't know what to do…. sometimes the teacher is just then like, were you listening? I don't think you were listening. And you're like, I was listening. I just don't know" [Class 2, draw and tell].

From their recommendations, it is evident that children want teachers to take time to really understand where they are in relation to learning mathematics, so that children's understanding can be used as a basis for future learning.

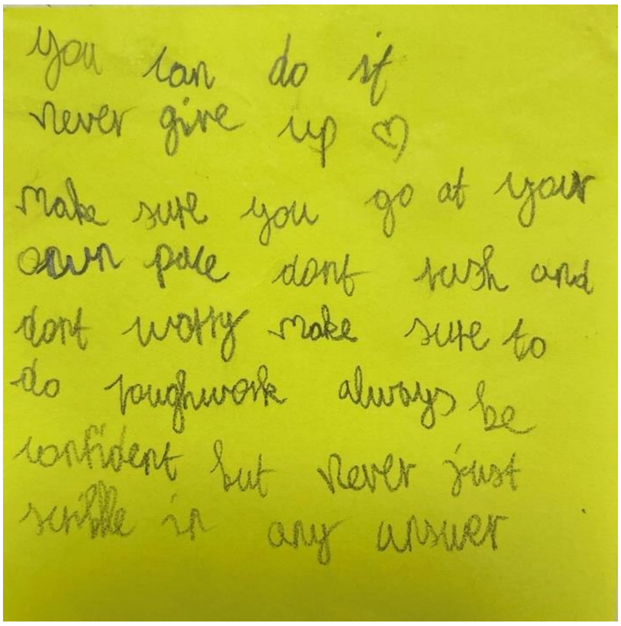
5.0 Summary and Conclusion

This research report provides valuable insights into the ways in which classroom mathematical experiences shape children's views of mathematics. Even taking into account the variation in children's experiences, and their personal preferences as learners of mathematics, some general patterns are evident.

In classes where the learning experiences were reported favourably, and children communicated a *positive disposition* toward mathematics, there was evidence of similar classroom practices. These practices align closely with recommendations from the international mathematics research literature and are also mentioned in recent NCCA research (Dooley, 2019). Children referred to both *cognitive and sociocultural perspectives* on learning. From a cognitive perspective, they valued achieving *mastery* of content and developing *rich mathematical understandings* but not at the expense of their lived experiences. They sought more *variety in the types of pedagogies and representations* used, greater use of *playful approaches* that support the development of mathematical understandings, and less emphasis on speed over accuracy. Closely related was children's emphasis on the sociocultural dimensions of learning. There was a clear and compelling mandate from all children for an increase in opportunities to *work collaboratively with their peers*, share their strategies, and engage in *mathematical discourse* at a small group and whole class level. Children who frequently engaged in these practices demonstrated positive dispositions towards mathematics, valued the input of their peers in the learning process and described doing mathematics as fun and enjoyable. They spoke with excitement of situations where they engaged in *problem solving activities*, especially those that drew on relevant and real-world contexts. For those classes that had experiences of open-ended problem solving involving *cognitively challenging tasks*, they demonstrated productive dispositions and communicated the importance and relevance of mathematics to their everyday lives. Interestingly, the practices valued by the children mirror advocated best practices in the teaching and learning of mathematics. In contrast, children attributed their negative experiences of mathematics to the *overuse of the textbook*, the *monotony* of procedures-based emphases in their mathematics activity and communicated a thirst for mathematics experiences beyond the textbook.

When asked to share advice, children were eager to communicate their expectations for approaches to teaching and learning mathematics. They recognised opportunities in which they could *take ownership of their own learning*, through peer support. These opportunities allow them to learn from each other, to discuss mistakes, explain concepts to each other in a 'child-friendly' way, work together on problems and projects and engage in self/peer assessment. Those who had experiences of such collaborative work understood the importance of *learning from mistakes*. It appeared that for children in these classrooms, the supporting structure of working with their peers provided the scaffold necessary to engage with, and value the challenge of cognitively challenging tasks, thus establishing the *desirable sociomathematical norms* that underpin and support these important practices. In such contexts, children not only learned mathematics, but they developed an appreciation for the value of mathematics and *productive dispositions* towards mathematics. Central to the development of these dispositions was the critical positioning of *context* at the centre of teachers' pedagogical practice and in the design of mathematically rich tasks. The children were enthused and energised by the interesting real-world contexts which, in turn, communicated the usefulness and value of mathematics in their everyday lives and in society. Again, there is a strong relationship between children's recommendations and the key pedagogical practices and approaches endorsed in the Primary Mathematics Curriculum Draft Specification (NCCA, 2022), for example *cognitively challenging tasks, maths talk* and *encouraging playfulness.*

Throughout, children expressed a deep commitment to their learning and demonstrated *metacognitive awareness* of their own learning styles and strengths. These skills could be further harnessed and utilised productively in the development of instructional and assessment strategies thus supporting the argument made by the NRC (2000) and Dooley (2019, p. 11) that "children's reasoning is at the centre of instructional decision making and planning ... children learn more effectively when they are actively involved in the process". Children also showed the ability to identify and appreciate valuable mathematical practices experienced in their earlier experiences of school. They reported on their favourite mathematical memories, often involving context-rich problem solving experiences or the use of constructivist pedagogies and linking mathematics with the outside world. Their ability to excitedly retell these experiences, some of which happened many years previously, attests to the influence that these innovative pedagogies have and the power of good mathematics teaching.


you can do it
never give up ♡
make sure you go at your
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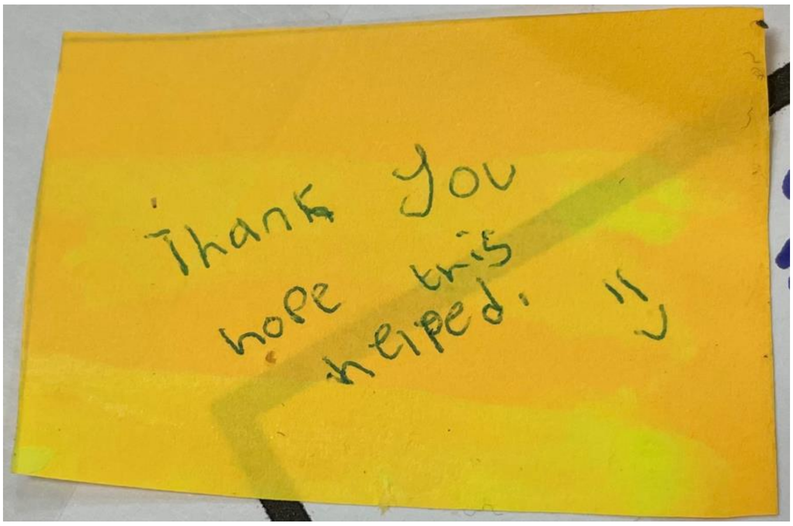
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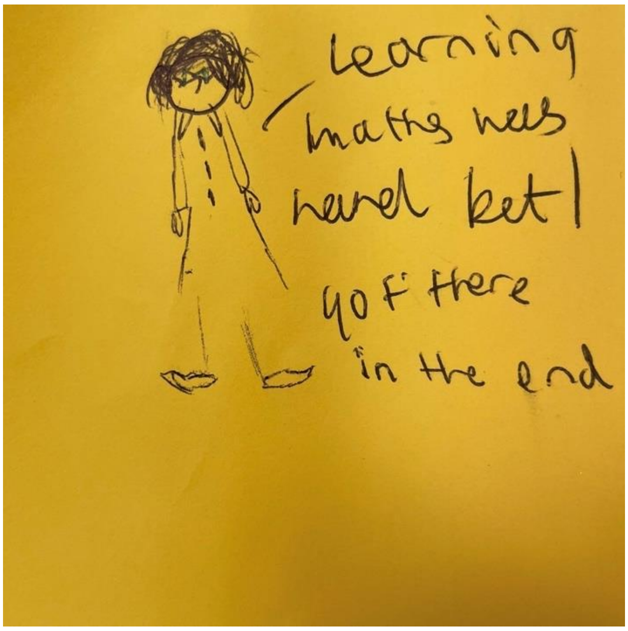
learning
maths was
hard but I
got there
in the end

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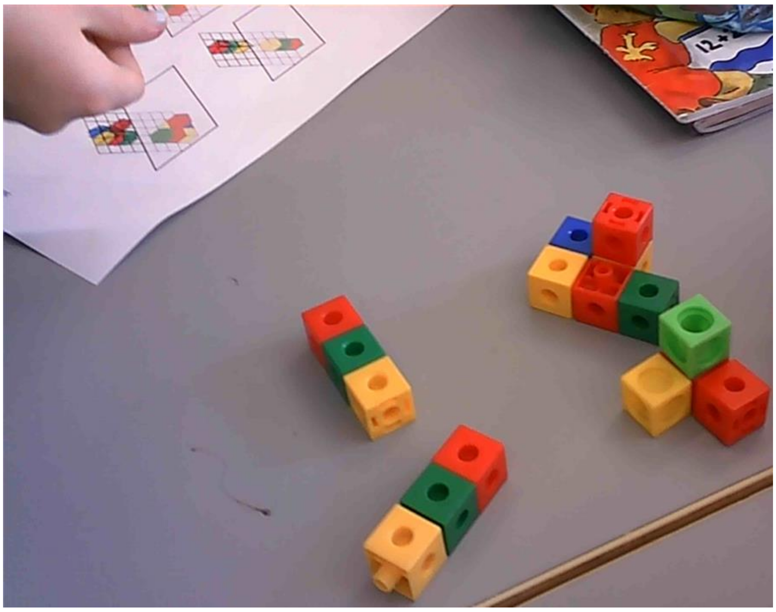


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Design Spec
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Cost
Pegs = 16 x 14 = £224
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