UNIVERSITY OF SOUTHERN QUEENSLAND
AUSTRALIA

IDENTIFYING THE FEATURES REQUIRED TO DESIGN A COLLABORATIVE ONLINE HOMEWORK SYSTEM, FROM A TEACHER PERSPECTIVE, THAT SUPPORTS A PARTNERSHIP BETWEEN TEACHER, PARENT, AND STUDENT FOR AUSTRALIAN YEAR 1 MATHEMATICS.

A Thesis submitted by

Mr. Adrian Hylton McGrath, B.Com

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ABSTRACT

The aim of this research has been to explore what is understood about collaborative online learning with a view to identifying the features necessary to design a collaborative online mathematics homework system that supports a partnership between Year 1 teachers, parents, and students.

This research has been guided by an epistemological framework within a pragmatic paradigm. Qualitative data was recorded through face-to-face paired depth interviews with teachers in their classrooms at their schools. Themes within the data were identified using Reflexive Thematic Analysis. Outputs include a description of participant experiences, teacher-parent-student relationship description, and a feature description. Contributions include insights to how participants currently connect online, their adherence to the Australian Curriculum, and how collaboration could be supported. Discussion includes identification of sixteen features demarcated into: eight features for a learning objective interface; and eight features to improve teacher/parent trust. Two main barriers were identified that could prevent effective integration of the required features and recommendations proposed to overcome those barriers to design a collaborative online homework system for Year 1 mathematics.

CERTIFICATION OF THESIS

This Thesis is entirely the work of Adrian Hylton McGrath except where otherwise acknowledged. The work is original and has not previously been submitted for any other award, except where acknowledged.

Principal Supervisor: Dr Neil Martin

Associate Supervisor: Dr Amy Antonio

Student and supervisors' signatures of
endorsement are held at the University

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GLOSSARY OF KEY TERMS

Term	Definition
Application (software)	An application (application or app for short) is a computer software program that is designed to carry out specific tasks as opposed to those that relate to the operation of the computer itself, normally to be used by end-users.
Bootstrapper	A person who relies on their own resources to solve a problem or pursue an undertaking (Oxford Lexico, 2022).
curriculum	A curriculum is a description of what, why, how, and how well a student should learn in a methodical and planned way.
Curriculum	The Australian Mathematics Curriculum.
Features (tangible)	A distinctive attribute or aspect of something tangible.
Features (teaching)	A unique characteristic or aspect of a teaching method.
Features (software)	A distinguishing characteristic of a software item, for example, performance, portability, or functionality. *Feature-rich* software usually has many options and functional capabilities available to the user.
Mathematics (math, maths, mathematic)	Mathematics is the science and study of quality, structure, space, and change.
Social Constructivism	Social constructivism is a sociological theory of knowledge according to which human development is socially situated and knowledge is constructed through interaction with others (McKinley, J., 2015).

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1. INTRODUCTION AND STUDY JUSTIFICATION

> See, the world is full of things more powerful than us.
> But if you know how to catch a ride, you can go places.
> (Stephenson, 1992, p. 101)

Teaching a child how to ‘catch’ their ride in life and watching them ‘go places’ is surely the ultimate reward for a teacher, with no more satisfaction abounding from their Year 1 teacher. Bridging the gap between home and formal school takes a special kind of teacher as they will likely be the first teacher to have to answer the question:

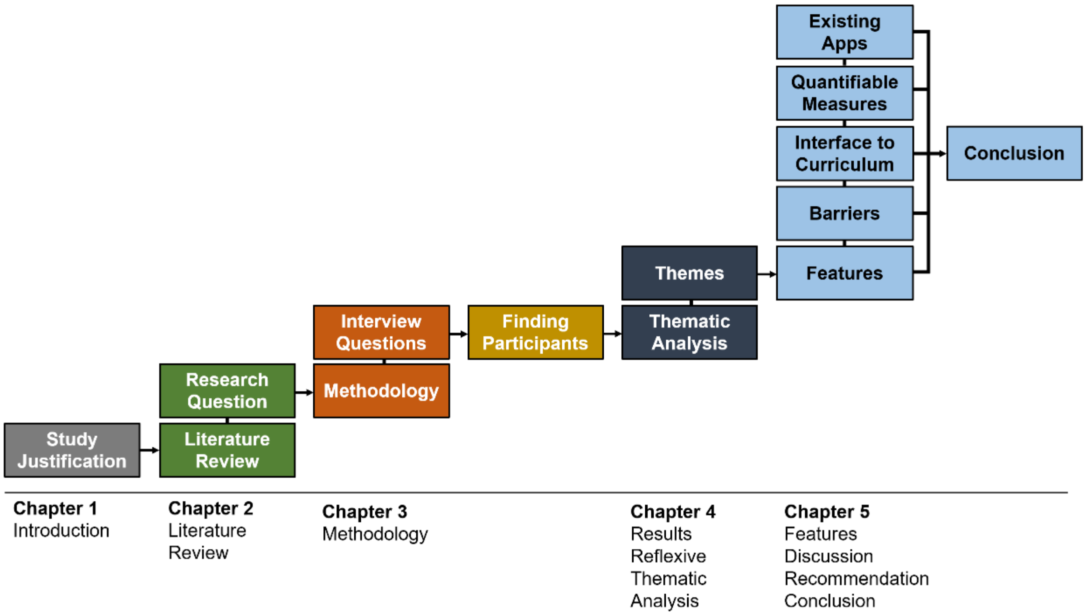
“Why is mathematics useful?”

With these young and happy minds Year 1 teachers weave imagination with ideas to explain mathematical concepts and facts, so that a sense of purpose can be realised every day for their students. At this level, teachers can show how ideas have the propensity to become reality, and with each new reality comes the opportunity for a better life experience (Peterson, 2021). They teach that imagination can provoke images of a possible future with the ticket to ‘go places’ being hard work and the application of their intelligence so that maths and science become a source of hope (Fridman, 2021a). After multiple years studying and teaching, these Year 1 teachers learn to craft the art and science of painting mathematics as beautiful, whilst also ensuring cognitive development so their students will one day be ready for great job opportunities that can lift themselves and their country into the top echelon of technology driven economies.

The aim of this research is to identify the features necessary to design a collaborative online homework system, that supports a partnership between teacher, parent, and student for Australian Year 1 Mathematics. Figure 1 shows the progression of this study chapter by chapter.

Figure 1

Chapter by Chapter Progression.



This present research opens in Chapter 1 with a justification for why improved mathematics development at Year 1 is useful and important both for the individual student and Australia as a global economic competitor and that homework is a good avenue to achieve this. This is followed in Chapter 2 with a literature review that studies the relationships students have with their parent(s) and teacher, and educational theories that would need to be understood to identify the features needed for an online collaborative homework learning system for mathematics at Year 1. This review provides the Researcher with the foundation to determine the research question. With this research question in mind the Researcher then describes the identification of a suitable methodology to gather the appropriate data in Chapter 3. The Researcher then provides the results of the data collection in Chapter 4 and follows this with a conclusion in Chapter 5.

1.1 Mathematics is Beautiful

Espousing the beauty of mathematics, Sherry (2019) felt compelled to write of the physicist Albert Einstein and the evolutionary biologist Richard Dawkins' wonder at the eloquence of the world noting Dawkins' (1999) "feeling of awed wonder" (p. xii) from studying science. Sherry later-on quoted the astrophysicist Subrahmanyan Chandrasekhar's personal allusion to mathematics as "shuddering before the beautiful" (p. 63). Indeed, in 1623, mathematics was at the forefront of Galileo's mind in his famous statement in 'Il Saggiatore' that "the great book of nature which lies ever before our eyes. . . is written in mathematical language" (p. 171). Isaac Newton (1718), in agreement with Galileo, went further by stating, "As in *Mathematicks*, so in Natural Philosophy" (p. 381). More recently, theoretical physicist and Nobel laureate Richard Feynman (1965), while discussing the usefulness of models, shared his belief that mathematics is a deep way of articulating nature itself. We see the beauty of mathematics on full display in nature in the Fibonacci Sequence (Fibonacci, 1202); a sequence of numbers starting with 0 and 1, and continuing by adding together the previous two, thus: 0, 1, 1, 2, 3, 5, 8, 13, and so on. This natural sequence fascinated mathematicians like Alan Turing (Swinton, 2004) and is exemplified in the structures of pineapples, pine cones, snail shells, sunflower heads, and many other things occurring in nature (Sherry, 2019). However, Einstein's excitement with scientific and mathematic discoveries extended beyond the universe's vastness and complexity and for him it reached to its intelligibility, and it was his belief that it was this perspicuity that enabled him to articulate theories, frame hypotheses, and posit explanations (Sherry, 2019).

1.2 Mathematics is Important for Cognitive Development

Mathematic type structures are defined by cognitive scientists where 'concepts' embody the most basic constructs in theories of the mind (Kirschner et al., 2006) and lay the foundation to understand how knowledge is stored (Kay & Kibble, 2016). Teachers apply concepts as building blocks (both figuratively and physically) to help their students identify and categorise things that belong together (Woolfolk Hoy et al., 2013). Along with categories, concepts are incorporated into larger data formations that characterize the common concepts stored in memory, so that all data representative of all concepts are exemplified in the mind as schemata (John-Steiner & Mahn, 1996). What this means for students at Year 1 is that the mathematical knowledge and experiences constructed in their first formal year of school, if stored in long-term memory, are kept within a deeply linked network (schema or schemata) that includes concepts and categories that are later developed and referred to as propositions, units, and elements (Anderson, 1983). Growing evidence provides a convincing description of a strong relationship between executive function skills (particularly short-term memory) and a student's mathematics achievement (Cragg & Gilmore, 2014).

At Year 1 students are presented with the first steps to achieving mathematical proficiency by drawing on a wide variety of skills and knowledge including working memory (central executive functioning and visual-spatial sketchpad), numeracy, and linguistic competence (Cowan et al., 2011). For over 50 years, the overall academic consensus with regard to working memory validates the notion that working memory is highly involved in goal-directed behaviours where information must be manipulated and retained to ensure successful task implementation (Chai et al., 2018). To compare *heritabilities* of several measures of literacy, numeracy, and cognitive ability, Kovas et al. (2013) studied 7,500 pairs of twins in the United Kingdom. They assessed these pairs longitudinally at ages, 7, 9 and 12, and found that differences between children are considerably and significantly more heritable for literacy and numeracy than for cognitive ability at ages 7 and 9, but not 12. Their reasoned explanation for this counterintuitive result is that there might be genetically determined neurocognitive processes – for example, using decontextualized language and abstract symbol systems – that lean on literacy and numeracy skills, but not 'general cognitive ability', when formal schooling begins. The importance of developing these numeracy skills at the start of formal schooling was also found by Dyson et al. (2011) in that number sense at this young age is a strong forecaster of later achievement in school mathematics, however, they also found that a disproportionate number of students from low-income families come to Year 1 with poor number competencies, which can introduce a cycle of failure. The study by Sheldon et al. (2010) further found that better family involvement in math-related practices helps students to score well on math achievement tests.

1.3 Mathematics can Provide for Great Job Opportunities

Teaching maths at Year 1, however, is not just about delivering content that can be later recalled in a test, more importantly it is about the way it neurologically constructs reason and logic functions that last a lifetime (Green, 2018). These functions can be applied to making societal laws (Martin, 1988), engineering rockets that return to earth (Teitel, 2021), developing precision medical instruments for complex surgeries (Kim et al., 2019), creating robots to simulate human interaction (Sheridan, 2016), crafting the geometric form for new mobile phones (Choate, 2021), calculating precise frequencies to deliver internet broadband (Froehlich & Ferguson, 2021), modelling different agricultural scenarios to optimise land use (De Rosa, 2018), managing building construction projects (Teamwork, 2021), stylising geometric shapes and patterns for design (Larson, 2017), formulating a firm's profit and loss and balance sheet with the accounting equation (Scott, 2021), coding a software solution to transform society's social connectivity (Kapoor et al., 2018), conceptualising embedded androids (Nørskov & Yamazaki, 2018) and human-machine communication (Fridman 2021b), developing blockchain cryptocurrencies (Little, 2021), developing search algorithms (Metz, 2021), developing probabilistic systems for self-driving cars and trucks (Fridman, 2021b), and estimating the probability of bad weather (Benjamin, 2019). The list of applications for mathematics and its reason and logic functions is gargantuan and the possibilities for job opportunities that offer better life experiences are plentiful, especially as employers require increased mathematically literacy and more numerate workers (Marr & Hagston, 2010; Hodgen & Marks, 2013; Henry-Nickie, 2018).

1.4 Mathematics Helps us in Everyday Life

While mathematic skills development can be a solution for complex technology development, we can also benefit from its assistance in everyday life. At the demanding end of intellectual application, Eagleman and Brandt (2017) characterised Richard Feynman as a successful physicist because he could flexibly move to another mathematical method whenever he was 'blocked', which demonstrated an example of how to deal with almost anything in life. Mathematics also helps us generally in everyday life from understanding COVID statistics, conceptualising climate change models, comparing square metering of properties, working out a household electricity bill, working out how many kilometres are in a mountain hike, calculating the calories in a hamburger meal, budgeting cashflow to save up for an overseas holiday, working out geometrical and symmetrical patterns for weaving (Jolie et al., 2011), determining the right proportions for cooking ingredients, and in the manufacture of mixed materials such as ceramics, glue, glass, concrete, and alloys (Hansson, 2020).

However, one unsettling question has festered with the Researcher from the start of this thesis through to the development of the research question and is summed up quite well by Clay Routledge (Peterson, 2021):

"If I'd worked harder at maths would my brain be better?"

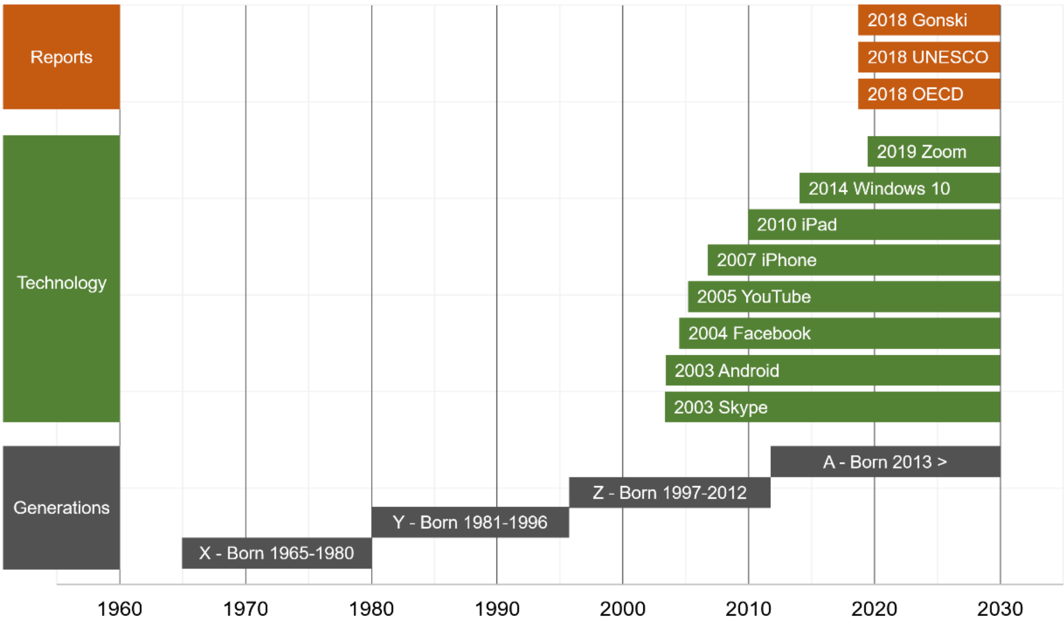
By extension, the Researcher considered whether his children's brains would be better if he had available an online collaborative homework support system for Mathematics, especially from induction at Year 1. Furthermore, could Australia provide better opportunities for his children if we were more competitive as a nation because of better mathematics development at school? The Researcher's personal quest to develop and explore this research question ignited over twenty years ago when he was a software developer for the secondary and tertiary education sector and sharpened more recently by his reflections on the frustrations of being a willing but unable-to-help parent during the primary school years of his own children.

1.5 Mathematics can Help Australia Perform Better Economically

Surprisingly, Australia has slipped in its rankings amongst its peers over the last two decades. What is more remarkable is that this has taken place during the most significant technological developments of our age – the Internet and its spread through desktop and private mobile devices (see Figure 2).

Figure 2

Generations since 1965, Revolutions in Technology since 2003, and Significant Education Reports in 2018.



Note. Figure 2 graphically describes the generations from 1965 to the present day (Dimock, M. 2019) alongside the revolutions in technology, and recent reports that identify Australia's comparative position globally.

Figure 2 contrasts the generations born from 1965, with the technology of the last two decades, and recent reports that identify Australia's educational and mathematical place in the world. This graphic shows the birth year of four generations from Generation X (1965-80), Generation Y (1981-96), Generation Z (1997-2012), and Generation A (2013-present). The children currently at Year 1 are members of Generation A, with most of their teachers being members of Generation X and Y (the Researcher is a member of Generation X and his three children are all members of Generation Z).

Figure 2 shows that in less than one decade, from 2010, communication solutions in technologies such as Skype, Android, Facebook, YouTube, iPhone, iPad, Windows 10, and Zoom all took root in our lives to digitally connect us together and, in many cases, offer us life-style improvements and a healthier work/life balance (Gewirtz, D., 2018). Prior to that time (from the mid-1990s), Australian education saw a preponderance of digital learning start-up companies attempting to integrate the internet through corporate offerings of websites, Flash apps, intranets, and internet data capture, the development of which was largely driven by one of two professions: experienced technology developers with little to no teaching experience; or experienced teachers developing software for the first time (The Learning Federation, 2001). Around 2010 the education sector largely saw the exit of individual entrepreneurial developers of either profession in Australia, and this is evidenced through the amalgamation of many products made prior to this such as those that contributed to The Learning Federation that were later acquired and published on the Australian Curriculum website by Education Services Australia (see Appendix D). In a similar time period, large-scale application markets emerged such as Apple's AppStore, Google's Play, and YouTube to become the default avenue for many digital education products and systems. Virtually instant synchronous communication (Skype, Zoom) and asynchronous storage (cloud servers, Messenger, Facebook, Instagram) developed over this period fulfilled Hawking's (1993) prophetic words "Mankind's greatest achievements have come about by talking." These products and devices worked together in different configurations and gained worldwide traction transforming how we communicate with each other and the outside world (Timetoast, 2021). This entrenchment of connectable devices provided the backbone for the rapid uptake of technology solutions like Zoom during the COVID19 pandemic with up to 300 million daily meeting participants and 3.5 trillion annual meeting minutes (Kent, 2021). Despite the unpredictable swerve in 2020 due to the COVID19 pandemic, secondary schools and education institutions adapted as best they could as there were (for the most part) already onsite digital hubs for their students or moving towards that direction (Department of Education South Australia, 2021). Bandwidth requirements in Australia for both institutions and students at-home (remote) soared and was met with various government investments to enable broadband infrastructure to be rapidly developed (Education Victoria, 2021).

Figure 2 (above) also shows the release of recent reports that bear significance to Australia's mathematics and education community. The Organisation for Economic Co-operation and Development (OECD) measurements since 2003 have exposed Australia as having one of the strongest declines in mathematics performance and proficiency levels (OECD Program for International Student Assessment [OECD PISA], 2018c). In 2003, Australia's mean performance in mathematics ranked statistically significant above the OECD average (see Appendix A, Figure A1) across six proficiency levels (see Appendix A, Figure A2), ranking 7th on the mean performance mathematical scale (see Figure 3).

Figure 3

Mean Performance on the OECD Mathematics Scale (2003).

Mean performance on the mathematics scale

		Range of ranks*			
		OECD countries		All countries	
		Upper rank	Lower rank	Upper rank	Lower rank
Statistically significantly above the OECD average	*Hong Kong-China*	-	-	1	3
	Finland	1	3	1	4
	Korea	1	4	1	5
	Netherlands	1	5	2	7
	Liechtenstein	-	-	2	9
	Japan	2	7	3	10
	Canada	4	7	5	9
	Belgium	4	8	5	10
	Macao-China	-	-	6	12
	Switzerland	4	9	6	12
	Australia	7	9	9	12
	New Zealand	7	10	9	13
	Czech Republic	9	14	12	17
	Iceland	10	13	13	16
	Denmark	10	14	13	17
	France	11	15	14	18
	Sweden	12	16	15	19
Not statistically significantly different from the OECD average	Austria	13	18	16	20
	Germany	14	18	17	21
	Ireland	15	18	17	21
	Slovak Republic	16	21	19	24
Statistically significantly below the OECD average	Norway	18	21	21	24
	Luxembourg	19	21	22	24
	Poland	19	23	22	26
	Hungary	19	23	22	27
	United States	22	24	25	28
	Russian Federation	-	-	29	31
	Portugal	25	26	29	31
	Italy	25	26	29	31
	Greece	27	27	32	33
	Serbia	-	-	32	34
	Turkey	28	28	33	36
	Uruguay	-	-	34	36
	Thailand	-	-	34	36
	Mexico	29	29	37	37
	Indonesia	-	-	38	40
	Tunisia	-	-	38	40
	Brazil	-	-	38	40

Note. Figure 3 shows Australia's upper rank mean performance on the mathematical scale tied with New Zealand at seventh in 2003. From *OECD PISA (2003)*, p. 9. © 2003 PISA, all rights reserved.

However, in stark contrast Figure 4 shows that by 2018 Australia's mathematics position has become not significantly different from the OECD average (OECD PISA, 2018b - see Appendix B, Figure B1).

Figure 4

Comparing OECD Countries' and Economies' Performance in Mathematics (2018).

Comparing countries' and economies' performance in mathematics

Statistically significantly **above** the OECD average
Not statistically significantly different from the OECD average
Statistically significantly **below** the OECD average

Mean score	Comparison country/economy	Countries and economies whose mean score is not statistically significantly different from the comparison country's/economy's score
591	B-S-J-Z (China)	
569	Singapore	
558	Macao (China)	Hong Kong (China)[1]
551	Hong Kong (China)[1]	Macao (China)
531	Chinese Taipei	Japan, Korea
527	Japan	Chinese Taipei, Korea, Estonia
526	Korea	Chinese Taipei, Japan, Estonia, Netherlands[1]
523	Estonia	Japan, Korea, Netherlands[1]
519	Netherlands[1]	Korea, Estonia, Poland, Switzerland
516	Poland	Netherlands,[1] Switzerland, Canada
515	Switzerland	Netherlands,[1] Poland, Canada, Denmark
512	Canada	Poland, Switzerland, Denmark, Slovenia, Belgium, Finland
509	Denmark	Switzerland, Canada, Slovenia, Belgium, Finland
509	Slovenia	Canada, Denmark, Belgium, Finland
508	Belgium	Canada, Denmark, Slovenia, Finland, Sweden, United Kingdom
507	Finland	Canada, Denmark, Slovenia, Belgium, Sweden, United Kingdom
502	Sweden	Belgium, Finland, United Kingdom, Norway, Germany, Ireland, Czech Republic, Austria, Latvia
502	United Kingdom	Belgium, Finland, Sweden, Norway, Germany, Ireland, Czech Republic, Austria, Latvia, France
501	Norway	Sweden, United Kingdom, Germany, Ireland, Czech Republic, Austria, Latvia, France, Iceland
500	Germany	Sweden, United Kingdom, Norway, Ireland, Czech Republic, Austria, Latvia, France, Iceland, New Zealand
500	Ireland	Sweden, United Kingdom, Norway, Germany, Czech Republic, Austria, Latvia, France, Iceland, New Zealand
499	Czech Republic	Sweden, United Kingdom, Norway, Germany, Ireland, Austria, Latvia, France, Iceland, New Zealand, Portugal[1]
499	Austria	Sweden, United Kingdom, Norway, Germany, Ireland, Czech Republic, Latvia, France, Iceland, New Zealand, Portugal[1]
496	Latvia	Sweden, United Kingdom, Norway, Germany, Ireland, Czech Republic, Austria, France, Iceland, New Zealand, Portugal,[1] Australia
495	France	United Kingdom, Norway, Germany, Ireland, Czech Republic, Austria, Latvia, Iceland, New Zealand, Portugal,[1] Australia
495	Iceland	Norway, Germany, Ireland, Czech Republic, Austria, Latvia, France, New Zealand, Portugal,[1] Australia
494	New Zealand	Germany, Ireland, Czech Republic, Austria, Latvia, France, Iceland, Portugal,[1] Australia
492	Portugal[1]	Czech Republic, Austria, Latvia, France, Iceland, New Zealand, Australia, Russia, Italy, Slovak Republic
491	Australia	Latvia, France, Iceland, New Zealand, Portugal,[1] Russia, Italy, Slovak Republic
488	Russia	Portugal,[1] Australia, Italy, Slovak Republic, Luxembourg, Spain, Lithuania, Hungary
487	Italy	Portugal,[1] Australia, Russia, Slovak Republic, Luxembourg, Spain, Lithuania, Hungary, United States[1]
486	Slovak Republic	Portugal,[1] Australia, Russia, Italy, Luxembourg, Spain, Lithuania, Hungary, United States[1]
483	Luxembourg	Russia, Italy, Slovak Republic, Spain, Lithuania, Hungary, United States[1]
481	Spain	Russia, Italy, Slovak Republic, Luxembourg, Lithuania, Hungary, United States[1]
481	Lithuania	Russia, Italy, Slovak Republic, Luxembourg, Spain, Hungary, United States[1]
481	Hungary	Russia, Italy, Slovak Republic, Luxembourg, Spain, Lithuania, United States[1]
478	United States[1]	Italy, Slovak Republic, Luxembourg, Spain, Lithuania, Hungary, Belarus, Malta
472	Belarus	United States,[1] Malta
472	Malta	United States,[1] Belarus
464	Croatia	Israel
463	Israel	Croatia
454	Turkey	Ukraine, Greece, Cyprus, Serbia
453	Ukraine	Turkey, Greece, Cyprus, Serbia
451	Greece	Turkey, Ukraine, Cyprus, Serbia
451	Cyprus	Turkey, Ukraine, Greece, Serbia
448	Serbia	Turkey, Ukraine, Greece, Cyprus, Malaysia
440	Malaysia	Serbia, Albania, Bulgaria, United Arab Emirates, Romania
437	Albania	Malaysia, Bulgaria, United Arab Emirates, Romania
436	Bulgaria	Malaysia, Albania, United Arab Emirates, Brunei Darussalam, Romania, Montenegro
435	United Arab Emirates	Malaysia, Albania, Bulgaria, Romania
430	Brunei Darussalam	Bulgaria, Romania, Montenegro
430	Romania	Malaysia, Albania, Bulgaria, United Arab Emirates, Brunei Darussalam, Montenegro, Kazakhstan, Moldova, Baku (Azerbaijan), Thailand
430	Montenegro	Bulgaria, Brunei Darussalam, Romania

1. Data did not meet the PISA technical standards but were accepted as largely comparable (see Annexes A2 and A4).

Source: OECD, PISA 2018 Database, Table I.B1.5.

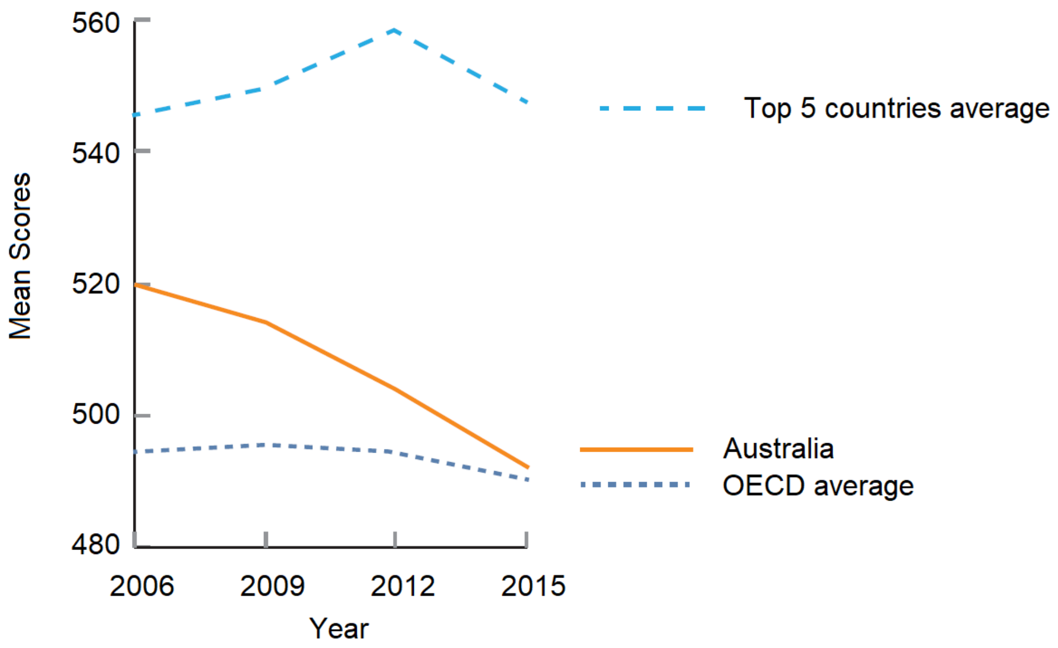
StatLink https://doi.org/10.1787/888934028254

Note. Figure 4 highlights Australia's position within the OECD average band. From *OECD PISA (2018b)*, pg. 59, (Table I.4.2).

The implication of this data is that despite being one of the world's biggest spenders, in terms of education, investing more than AUD$150,000 per student from Year 1 to Year 10 (OECD PISA, 2018c), of the top performing countries in the world, Australian mathematics performance and proficiencies are declining in relation to leading OECD countries. Figure 5 graphically shows the starkness of Australia's lag in mathematics (Gonski et al., 2018).

Figure 5

Australia is lagging behind the world's top performers and falling towards the OECD average.



Note. Figure 5 is derived from OECD, PISA database 2006–2015. The top five countries average uses the scores of the top 5 performing countries participating in PISA for each subject in each PISA year. From *Gonski, et al. (2018)*, pg. 10, (Exhibit 6). © 2018 Department of Education and Training, all rights reserved.

Chinese territories made up the majority of the top performers (see Figure 4) and this coincides with China's poverty eradication campaigns during this period (1990-2018) that focused on improving education (CGTN, 2020). A Chinese national focus on education produced a strong desire amongst its population to move out of poverty and seek an improved life (Goodman, 2021). This movement outperformed its international competitors resulting in the highest number of graduates, 40% of whom finished a STEM degree (McCarthy, 2017; Stapleton, 2017). In contrast, over this same period, Australian’s have had access to: high quality education; a minimum wage; a social safety net; affordable housing; and a high standard of healthcare. While both Chinese and Australian students have had access to technology over this period, much research has considered whether technology (and social media) has made Western students lazy in their studies considering there is less need to escape poverty (Andrews, 2016; Technality, 2021; Milan, 2021).

Although the number of students with strong mathematical knowledge and skills is a predictor of the future competitiveness of a knowledge-oriented economy (Committee for Economic Development of Australia, 2015), a country’s proportion of students who lack basic mathematics skills is also a predictor of the viability of a nation’s ability to rank with the top knowledge countries (OECD PISA, 2003). For Australia to climb back into the competitive zone of STEM (Science, Technology, Engineering, Mathematics) knowledge economies, it must first adopt better tools that provide communication that is friendly to a partnership between those in the economy that have the ability, training, and experience to teach mathematical understanding (teachers and parents) and their students/children. Furthermore, the need for successful online mathematics homeworking solutions for primary aged students has become ever more prominent in the context of the COVID-19 global pandemic. On a macro scale this would be an important step for Australia to understand how it could lift its rankings among OECD nations in Mathematics and grasp at the next technological advancement.

During this same period, mass education underwent a colossal upheaval in the early 2000s (Galguera, 2018). From 1999 to 2015, over 80 million more children were enrolled in school worldwide, with an increase from 84% in 1999 to 91% in 2007 of universal primary enrolments (UNESCO, 2015). However, Gonski et al.’s recent report (2018) exposed Australia as having a school system that “reflects a 20th century aspiration to deliver mass education to all children" (p. ix) that is concentrated on attempting to certify that millions of students realise specific learning outcomes for their grade and age before moving them to the following year of schooling. Gonski et al. further notes that Australia's education model is not constructed to distinguish learning or extend all students to ensure they achieve maximum learning growth every year. The report further advises that students in Australia should not leave school without the essential skills and capabilities they will need to take part in the workforce and lead productive and fruitful lives.

1.6 Mathematics is the Backbone for Technological Advancement

Gonski et al. (2018) also noted that school education must prepare students for a complex and quickly shifting technology-led world. The technologies we use today are based predominantly on established mathematic and scientific theories such as electrodynamics, thermodynamics, quantum mechanics, solid mechanics, and fluid mechanics. All these technologies necessitate significant mathematical training. Furthermore, engineering has seen a rapid growth in the development of additional mathematical tools, for example simulation, control theory, optimization, and statistical analysis (Hansson, 2020). As routine manual and administrative activities are progressively automated (Autor & Price, 2013), additional jobs will demand greater levels of skill, and more school leavers will require skills that are not easily replicated by machines. Skills such as problem-solving, interactive and social skills, collaboration, interpersonal skills, and critical and creative thinking, will be needed in greater capacity within realms driven by artificial intelligence development and accelerated automation. Thus, revolutionary technologies will continue to reshape Australia's job architecture, reducing the need for lower-skill routine manual work and routine cognitive work and increasing the need for higher skill non-routine manual and non-routine cognitive work (Gonski et al., 2018).

1.7 A Student's Early Relationships are Critical to their Development

A child's parents, carers and other family members have a significant influence on their success at school (Emerson, 2012) and the fruit of these relationships bears out from their first five years where their cognitive abilities rapidly develop to become the foundation for their lifelong learning (Burger, 2010). This foundation includes numeracy, literacy, language, communication, social abilities, and emotional skills (Australian Government, 2009). However, students start school at Year 1 with differing levels of these abilities and those who start with the strongest learning foundations are more likely to be determined and effective learners at school (Gonski, 2018). Some states, such as Queensland, have a preparatory year and this can affect a student’s schooling foundation. Toll et al. (2011) found that students who fail to gain basic numeracy knowledge by the time they have entered formal education at Year 1 are at high risk for developing mathematical learning disabilities. Unfortunately, the disparity in Australia between students from an advantaged family background and those from a disadvantaged family background increases from 10 months in Year 3 to around two-and-a-half years by Year 9 (Goss et al., 2016). This means that students who do not develop maths skills at an early stage will be even further disadvantaged later in life, and this is exacerbated, more so if from a disadvantaged background.

1.8 Homework

Homework can be defined at its core as extra curricula activities set by a teacher to be completed at home. Fitzmaurice et al. (2020) understood that homework per se is seen as a ‘pervasive pedagogical practice’ constructed around the culture in the society within which it operates. Their study identified a teacher’s cultural values and ideologies as factors that influence a teacher’s homework practices. In other words, no ubiquitous definition of practice can be used to describe the term ‘homework’ that will satisfy all locales of its application. However, it must be noted at the outset that this present study is focused on ‘homework’ and is to be distinguished from ‘home-class work’. The former being the additional extra curricula learning work a student will do at home (with or without assistance from their parent) and the latter being the learning work at home that would normally take place in class with a teacher that takes place remotely at home, for example as a result of the COVID19 pandemic.

Mathematics homework, more specifically, has been found to improve problem-solving skills, nurture critical thinking, promote individual learning and self-discipline, foster pride in achievement (MathProject, 2020), increase memory and thinking capacity, drive students to review class materials, provide an avenue for teachers to know the effectiveness of their teaching, and impart positive habits, study skills and research skills (HomeworkDoer, 2019; Grills, 2017). Building on prior research on formative assessment and adaptive teaching Roschelle et al. (2016) found that combining an intervention of an online homework tool combined with teacher training increased learning through their study of a randomized field trial with 2,850 Year 7 mathematics students. Their results demonstrated that their mathematics homework intervention significantly increased student scores when compared to a control group that continued with existing homework practices. They also found that students with low prior mathematics achievement benefited most. However, these studies do not specifically address Year 1 mathematics homework.

1.9 Proposed Contributions to the Field of Research

It is perhaps a utopian ideal put forward by the Researcher that if a system could be built that engages teachers and parents of Year 1 students in the homework setting and is in line with the Australian mathematics Curriculum (from herein referred to as “Curriculum”), then we could simultaneously achieve better brains for our children and be a more competitive country on a global scale. On worldwide standards it is a privilege for the Researcher to attend a university and study this issue and try to outline a solution that provides an insight to how teachers of Year 1 Australian Mathematics students currently connect online with the Australian Curriculum and how it could support more collaboration. This thesis seeks to identify the design features from a teacher perspective and begins with a review of literature based around the relationship between teacher, parent, and student. This is followed by a selection of educational theories for application development and application measurement and a brief study of the learning technologies offered by the Curriculum.

The understanding gained from this study will inform the development of a future collaborative online homework system for Year 1 maths, which is imperative at a time when teachers, parents and students have been forced to become accustomed and more conversant to punctuated engagement in classes online at home as a result of this current crisis and future pandemics. The aim of this research, therefore, is to identify the features necessary to design a collaborative online homework system, that supports this partnership between teacher, parent, and student for Australian Year 1 Mathematics.

1.10 Summary of Thesis

This opening chapter introduced mathematics as: beautiful; important for cognitive development; a provider of great job opportunities; helpful in everyday life; assisting Australia to perform better economically; and a backbone for technological advancement. Further, a definition of homework was provided, and the purpose and possible contribution of the research was considered.

Chapter 2 reviews the literature regarding; the relationship between teacher, parent, and student; educational theories for application development; educational theories for application measurement; and system design and development. This chapter culminates with the research question.

Further, Chapter 3 outlines the methodology and research design adopted for this study by the Researcher including: the epistemological viewpoint; pragmatic paradigm; a preview of the way the data is to be analysed through Braun and Clarke's Reflexive Thematic Analysis; determining and justifying the participant group and group size; participant inclusion/exclusion criteria; an exposé of paired depth interviews; ethical limitations; the interview questions; and the intended outputs of the data analysis.

In Chapter 4, a step-by-step application of Braun and Clarke's Reflexive Thematic Analysis is presented, specifically: data familiarisation; systematic data coding; generation of initial themes from coded and collated data; development and review of themes; refining, defining, and naming of themes.

Chapter 5 positions the themes associated with the research question and the features from the Participant/Teacher's perspective; identification of the barriers to developing the features into a collaborative online homework system; provision of recommendations to overcome those barriers; identification of existing applications provided in the Curriculum and those used by the Participants to review whether any provide the required features. Finally, a conclusion specifies the required features for an online collaborative homework system for Year 1 mathematics: eight features for a learning objective interface and eight features for improved teacher/parent trust.

2. LITERATURE REVIEW

Introduction

This chapter reviews the literature pertaining to the identification of the features necessary to design a collaborative online homework system for Year 1 mathematics. It commences with an exploration of what is currently understood about collaborative online learning, followed by an identification of the features necessary to design a collaborative online homework system. It is set out in four parts and concludes with the study's purpose and research question:

- Part 1:The Relationship between Teacher, Parent, and Student
- Part 2: Educational Theories for Application Development
- Part 3: Educational Theories for Application Measurement
- Part 4: System Design and Development
- Part 5: Purpose of this Study and Research Question

The purpose of this literature review is to inform the study's choice of methodology and participant questions, in order to reveal how mathematics is taught by teachers and to identify the features needed to develop a collaborative online homework system for mathematics at Year 1. In this study a feature can refer to tangible features such as hands-on manipulatives, intangible features such as software programs, and teaching features such as particular teaching methods. Parts 1-3 explore different facets of learning and education from the literature and compares them to this study's aim. Part 4 provides a brief review of system design and development that could be applied for this solution. Part 5 outlines the purpose of the study and concludes with the research question. This study is written within the setting of the 2020-21 COVID-19 pandemic, during which we witnessed two gaping holes in our primary school mathematics education system that have likely resulted from home isolation remote learning (McCutcheon, 2020):

- Parents of primary school children realise firsthand it is not easy to teach even just one child at home.
- Current technology does not facilitate homework collaboration

between parent, student, and their teacher, and the Australian Year 1 Mathematics Curriculum

2.1 Part 1: The Relationship between Teacher, Parent, and Student

Part 1 considers various aspects of the relationships between the stakeholders: teacher, parent, and student. The review starts with these relationships because they are the first bridge of commonality that all three stakeholders share. The relationship between a student and their Year 1 teacher may be a student's first form of strict structure and this puts the Year 1 teacher in a unique position of being the recipient of a handover of responsibilities and trust from the parent. These aspects start with a parent's involvement with their child at home, student engagement, positive parent-student relationships, student-teacher collaboration, positive attitudes towards technology, homework as a cultural phenomenon, teacher/school avoidance of homework, additional orders of difficulty for teachers, and parental resistance to homework collaboration.

2.1.1 Parental Involvement with their Child at Home

Before formal schooling, a child's number learning begins at home and develops through informal experiences (Ginsburg et al., 2008) in situations where their parents have been especially good at being involved and helping them make mathematical connections (Bransford et al., 2000). At home mathematics toys include Tinkertoys, board games, decks of cards and building blocks (Pappas, 2020). In Australia, the first year at primary school is where children around the age of 6 and 7 start their formal mathematics learning as relative mathematics *novices*. As novices they may arrive at Year 1 with a range of abilities such as simplistic concepts of time and date, length, height, and shape, and may be able to count, and match like and unalike (Leinhardt, 1989). Once in class their teachers face a difficult time entering each child's mathematical purview and identifying the unique experiences that have created whatever lattice of mathematical knowledge they bring from home to the classroom (Bransford et al., 2000).

Early studies, including Cooper et al. (2000), found that student achievement is positively related to parental involvement in homework and

Hoover-Dempsey et al. (2001) found parental involvement helps develop attitudes and behaviours associated with even higher achievement. Parental involvement has also been linked to a child's improved achievement, academic performance, self-regulation, study habits, positive attitudes, and fewer discipline problems (Fan & Chen, 2001; Masten & Coatsworth, 1998). Other studies (Baker, 2003; Margolis, 2005) have found that when parents are involved in their children's homework, the learning value of the homework to the student increases. However, Rothman et al., (2018) found they were not successful in developing a measure of parent engagement despite previous attempts by a number of researchers over the previous three decades. Furthermore, it must be noted that these studies do not discuss the value of any mechanisms or technologies that facilitate student engagement through parental involvement with the teacher and the Australian Curriculum.

2.1.2 Student Engagement

Ainley (2006) discussed the importance of student engagement and student motivation on learning outcomes and Appleton et al. (2008), much like Newmann (1992), found student engagement to be a multidimensional construct that necessitates understanding of effective connections within the academic environment. Alcena (2014) and Moore (2007) both understood this construct and surmised that self-directed learning is anathema to school students due to limited self-motivation and determination, especially when they are distance learners – a regression so plainly seen as a result of this recent worldwide pandemic with so many students relying on parental support to complete their learning at home. While these studies investigate the psychology that predicates a student's academic achievement - given parental contribution - they do not adequately describe how this will work with any technology that facilitates collaboration with their teacher and the Australian Curriculum in the home setting, and in particular for year 1 mathematics students.

2.1.3 Positive Parent-Student Relationship

Webstat and Policy Studies Associates (2001) identified parental involvement as being helpful for students with low achievement with their study for the U.S. Department of Education. They found that low-performing Year 3 math students made bigger gains when their teachers involved the students' parents. Quantitatively, the researchers found that math scores increased at a 40% higher rate in Year 3 through to Year 5 due to parental involvement when compared to classes that had low parental involvement. They also found that when parents meet in person with their child's teacher, keep in touch about their child's development, take home resources from teachers, and attend workshops teaching them to help with math at home, their child's math achievement scores were higher (Webstat and Policy Studies Associates, 2001).

Lam (2004) recounted efforts to involve parents of his class of primarily low socioeconomic Hispanic students in their education as only three students the previous year passed New York's state English Language Arts (ELA) and math tests. The involvement of parents in test preparation workshops and improved interpersonal relationships saw his class improve from 57% and 74% passing ELA tests and math tests to over 90% of his students passing both tests a year later. The study by Katz et al. (2011) also found parental behaviour that supported their child's psychological needs positively correlated to their child's autonomous motivation for doing homework. Also, a study of children aged 5-19 by Jewitt and Parashar (2011), from low-income households enrolled in England's HAP program (Home Access Programme – provision of one computer and one year of internet connectivity), found that HAP increased student engagement in homework and independent learning activities. Jewitt and Parashar's evaluation further showed evidence of increased parental engagement. More recently, Dumont et al. (2014) determined that student academic functioning, parental control, and parental responsiveness are active *positive* factors at the grade 5 and 7 levels. Gulevska's (2018) more contemporary research concurred with this outcome that parental involvement increases student achievement as well as improving attendance and student behaviour.

However, while these studies affirm the importance of a positive parent/student relationship, they do not examine how technologies will promote mathematical learning improvement in the homework setting. As such, there is scope for research on how technological intervention allows students to collaborate through the Australian Curriculum and with their teachers.

2.1.4 Student-Teacher Collaboration

Ertmer and Ottenbreit-Leftwich (2013) built on the early work of Jonassen (1996) that proposed the use of technology-enabled learning. While they closely linked future achievement of technology integration with pedagogical goals, they found that despite significant investments of time and money in infrastructure, training, and support, there is little evidence that teachers will use technology in their teaching. However, their focus was aimed at technology support system integration in the classroom setting, as opposed to the homework setting, which does not require comparable investments of time and money. Furthermore, while their study helps teachers engage students in authentic technology-enabled learning environments so that technology integration becomes the means by which students engage in relevant and meaningful interdisciplinary work, their study does not address what technologies can support collaboration between the stakeholders at home.

2.1.5 Positive Attitudes towards Technology

Blackwell et al. (2014) surveyed over 1,200 early childhood educators and found that attitudes toward the value of technology to aid children's learning have the strongest effect on technology use and integration. They further found that socioeconomic status had the strongest influence on attitudes towards technology use for students whereas, for teachers, support and technology policy influence had the strongest influence on attitudes towards technology use. This study was aimed at technology use in the classroom, rather than its use in homework. Furthermore, the data was procured only from teachers and not from students (nor their parents).

Alongside positive attitudes, the much-cited analyses of school reform literature by Klem and Connell (2004) found that students who are engaged with their learning do more than attend or perform academically. They also put forth effort, persist, self-regulate their behaviour toward goals, challenge themselves to exceed, and enjoy challenges and learning. Similarly, a study by Chan et al. (2013) involving 526 students, found student engagement coupled with higher quality relationships between teachers and parents were significantly associated with better youth outcomes, including self-esteem, academic attitudes, prosocial behaviours, and less misconduct. However, these studies did not focus on student use of technology support systems in the homework setting (at the primary school grade levels).

While maintaining engagement with students in the classroom can provide positive academic results, it is thought that the perceived quality of homework tasks affects students' experience of unpleasant homework-related emotions and Dettmers et al. (2011) described that this negatively predicts later achievement in mathematics. As for teachers' attitudes, Celik and Yesilyurt (2013) found evidence that attitudes to technology - perceived computer self-efficacy and computer anxiety - are important predictors of teacher candidates' attitudes toward using computer supported education. However, Dettmer et al.'s study idealised homework to be exclusive of any facilitating technology and is limited to one discipline (mathematics) and Celik and Yesilyurt describe teacher attitudes in general, rather than in relation to homework technology at the primary school level. In contrast to these studies, Rosário et al. (2015) extensively studied 27 Portuguese mathematics teachers and 638 sixth grade students, examining three non-technology homework purposes - practice, preparation, and extension. The study found that extension homework positively affected achievement more than practice and preparation homework. However, while Rosário et al.'s study emphasized the importance of the teacher's role in the first phase of the homework process, this study was limited to Portuguese participants, one student grade and discipline, and was exclusive of any facilitating homework technology. Their study does suggest that homework support systems could be a tool to extend students who love mathematics as well as helping to keep other students engaged with practice and preparation.

Prodromou et al. (2015) pondered the question of whether the challenges outweighed the benefits of technology integration - that result in transference of control from teachers to their students in the classroom setting, even when teachers have extensive knowledge of the technology. Prodromou et al. further queried whether such an integration would be successful without significant teacher preparation and training. However, Prodromou at al.’s study was confined to Hungarian ninth grade teachers who integrated a sequence of mathematics lessons using a pedagogical framework for technology integration in the classroom setting only and did not consider any collaborative contribution with parents.

Rudman (2014) noted that many schools work hard to meet many of the demands of parents who are frequently willing to help their children's learning at home but who struggle to understand how to do so given that teachers are often bound to homework methodologies devised in the early twentieth century. This sentiment echoed the earlier exposition by Plowman et al. (2011), which posited two qualifying questions: will access to technology at home lead to increased use; and what roles do parents play in supporting learning? Likewise, Olmstead (2013) speculated: would incipient technologies better facilitate parent-teacher communication; and would proactive parental involvement necessitate their physical presence? While these precepts prompt consideration, they lack a definable roadmap towards collaborative support technologies in the homework setting in the primary school sector.

2.1.6 Teacher/School Avoidance of Homework

Many teachers avoid homework (certainly for Year 1 students) and in some situations schools themselves set a “no homework” policy (Carmody, 2018, para. 2). A Perth primary school principal espoused the view that students work hard and are on task while they’re at school so that they can do something else after school that is not a stress on their parents (Carmody, 2018). Basinger (2018) described her experience as a teacher identifying five reasons why students should not be overloaded with homework: students are encouraged to learn; they are better rested and focused; free time makes them well-rounded; a balanced workload supports mindfulness; and family time is valuable to wellbeing. Basinger’s (2018) rationale was based on providing a quality of work/life balance for her students as she would often hear complaints her students were overworked. However, Basinger noted how difficult it was as a teacher of students with learning disabilities to determine the difference between a genuine concern or whether students were just trying to take the course of least resistance, adding that giving too little homework bores students but too much can overwhelm them.

2.1.7 Difficulty Setting Homework for Teachers

Carmody (2018) noted that all teachers should be inspired to understand what good homework practices look like. The main focus of an online collaborative system for teachers would be to inspire the use of technology to create the strands of communication that would make immediate the sharing time and marking of completed homework. It would also provide ready-made content that matches exactly to the learning objectives of the Curriculum. Many former teachers and education bodies have written strategies to help teachers manage and deliver homework to avoid it becoming an added difficulty of their job (AFT, 2021; Tierney, 2021; Tingley, 2021). Warger (2021) identified five homework strategies for teaching students: use a homework calendar; give homework assignments that are appropriate for each child’s level and with clear instructions; make homework accommodations; teach study skills; and ensure clear home/school communication. However, Warger’s research primarily studied students with learning disabilities and not specifically Year 1 mathematics.

2.1.8 Parental Resistance to Collaborating with their Child’s Homework

Formal mathematics education involves terms such as topics, learning objectives, learning outcomes, proficiency, and ability groups and may begin to make inherent sense to students and parents at secondary and tertiary levels as their experience of formal learning widens. However, for students and their parents at primary level, these terms along with the myriad of mathematical terms contain no real conductive meaning (Fisher, 2020; Hogan, 2019; Mathnasium, 2016). In many instances it is the parents who are reticent to work with their children to complete homework (Hargis, 2015; Barish, 2012). Many factors may contribute to this, however, the main driver of parental resistance is that homework delivery is not unified or easy for parents to deliver and synchronised at their child’s level of development, which creates an unknown optimal time requirement of the parent (Anderson, 2016; Hamlin, 2019). This is further exacerbated as work responsibilities have changed over the generations where, in many instances, both parents work full-time, and there may be more than one child at home requiring parental assistance with homework (Shepherd, 2010). This perspective will need further investigation to understand how a collaborative online system could be introduced to this group and speak to the benefits for their children and how to include quick training for parents ‘on the fly’.

2.2 Part 2: Educational Theories for Application Development

Having discussed the relationship between teacher, parent, and student in Part 1 it is necessary to consider in Part 2 some of the educational theories and pedagogical practices that could impact on the development of a collaborative online application for year 1 mathematics. This includes Vygotsky’s social development theory, Vygotsky’s levels of development, feedback, and strategies to help a student learn mathematics, namely mathematical instructional models, explicit instructional models, strategic instructional models, concrete-representational-abstract (CRA) teaching sequence, imagery, and knowledge. Vygotsky’s theories are most pertinent to the context of mathematics learning and development as they are conceptualised as methods that involve collaborating, participating, and communicating, thus they can be operationalised as a way to discover the growth of students’ mathematical thinking (Walshaw, 2017).

2.2.1 Vygotsky, Social Constructivism, and Social Development Theory

The work of Lev Vygotsky (1896-1934) has become the basis of much research and theory in cognitive development since his death in 1934, particularly what has become known as social development theory or sociocultural theory (Langford, 2005). Most of Vygotsky’s work and theories were incomplete by the time of his death at the age of 38 but they have been developed and translated from his native Russian to explain socialisation’s affect on the learning process of the individual (Tudge & Rogoff, 1999) and how community plays a dominant role in the process of making meaning for the individual (Vygotsky, 1978).

Constructivism per se, or individual constructivism, emphasises an individual’s personal experiences in their construction of knowledge. Social constructivism, however, emphasizes how social interactions impact an individual’s construction of knowledge (Lohman, L., 2021). Vygotsky posited his social constructivism theory that knowledge is not a duplicate of an objective reality but instead it is the result of the mind selecting and making sense of and recreating experiences. The implication of this is that knowledge is the outcome of interactions between both subjective factors and environmental factors (Lohman, L., 2021).

Sociocultural theory, centres on how the beliefs, values, customs, and skills of a social group are transferred to the next generation. According to Vygotsky, interaction within social settings, such as cooperative dialogues with more knowledgeable members of society, are essential for children to develop the ways of thinking and behaving that form a community’s culture (Rowe & Wertsch, 2002). Vygotsky’s work and theories have been particularly influential in the study of cognitive development. He viewed cognitive development as a socially mediated process that places greater dependence on the platforms and support provided by adults and more mature peers as children attempt new tasks. Vygotsky further theorised that children experience certain stagewise adjustments, such as when they acquire language, that positively affect their capacity to contribute to dialogues with others. He also theorised that their mastery of culturally appreciated capabilities surges providing dramatic advances in reasoning and problem solving.

Vygotsky identified that adults and more expert peers provide the help for children to master culturally meaningful activities and that the communication between them becomes part of children’s reasoning. As children take on the essential elements of these dialogues, they are able to use the language within them to direct their own thoughts and actions resulting in the acquisition of new skills (Berk, 2003).

While most of the research inspired by Vygotsky’s work focuses on children, his theories can apply to people of any age and suggest that people in every culture develop their own unique strengths in a similar way. More contemporary supporters of Vygotsky grant the individual and society more balanced roles (Karpov, 2005). Within any given culture, one theme that is ubiquitous is that tasks are selected for individuals by the wider group and social interaction encompassing those tasks lead to proficiencies vital for success in that culture. For example, in industrialized nations, driving instructors teach people to drive a car, teachers help migrants learn to read in another language, or tutors teach students to use a computer. Adult members of the Zinacanteco Indians of southern Mexico, expertly guide young girls as they master complicated weaving techniques (Greenfield, Maynard, & Childs, 2000). Child candy sellers in Brazil who have no formal schooling develop sophisticated mathematical skills as the result of purchasing candy from wholesalers, pricing it in cooperation with adults and experienced peers to bargain with customers on city streets (Saxe, 1988).

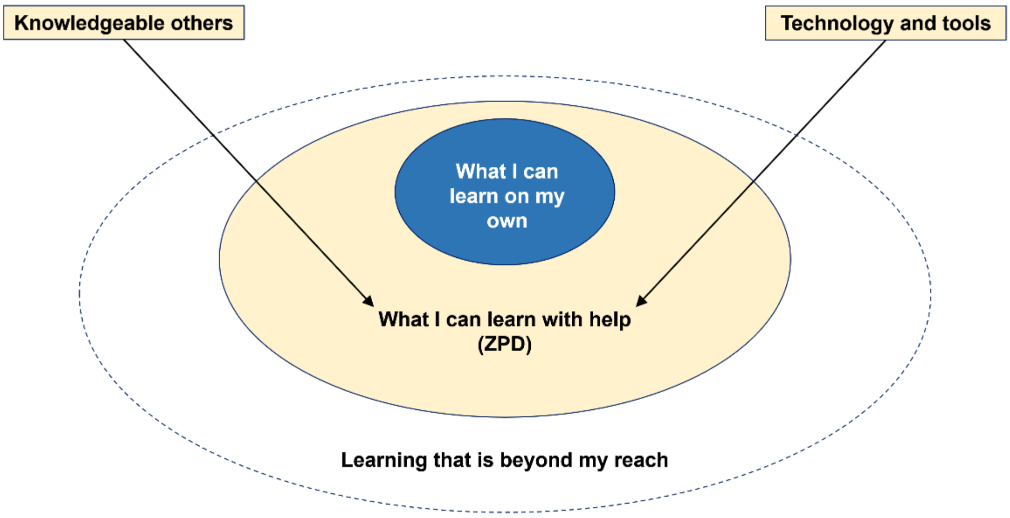
2.2.2 Vygotsky's Levels of Development

Vygotsky argued, "learning is a necessary and universal aspect of the process of developing culturally organized, specifically human psychological function" (1978, p. 90), meaning that social learning tends to come before development. Vygotsky's theories have been adopted, advanced, and conceptualised within the study of learning through three levels of development: a student's 'actual level of development'; the student's 'zone of proximal development'; and the student's 'higher level of potential development'. The centrepiece of Vygotsky's theory is the 'Zone of Proximal Development' (ZPD) which is the zone where a student is able to master a skill with guidance from a more capable peer (Parker, 1979), where a 'peer', for the purpose of this thesis, refers to either the student's teacher or their parent. Vygotsky defined this concept as being crucial to a child's development of their cognitive ability emphasising the social interaction with a more capable peer (expert) or knowledgeable adult as the first stage of a child's learning.

Figure 6 represents the ZPD through sets and boundaries centred around what a student is able to learn without assistance. What a student is able to learn with help from knowledgeable others (such as a parent or teacher) and technology tools surrounds what the student can learn on their own and this is identified as the Zone of Proximal Development (ZPD). Beyond the ZPD boundary is learning that is beyond the student's reach with or without the help of knowledgeable others or technology tools.

Figure 6

The Zone of Proximal Development.

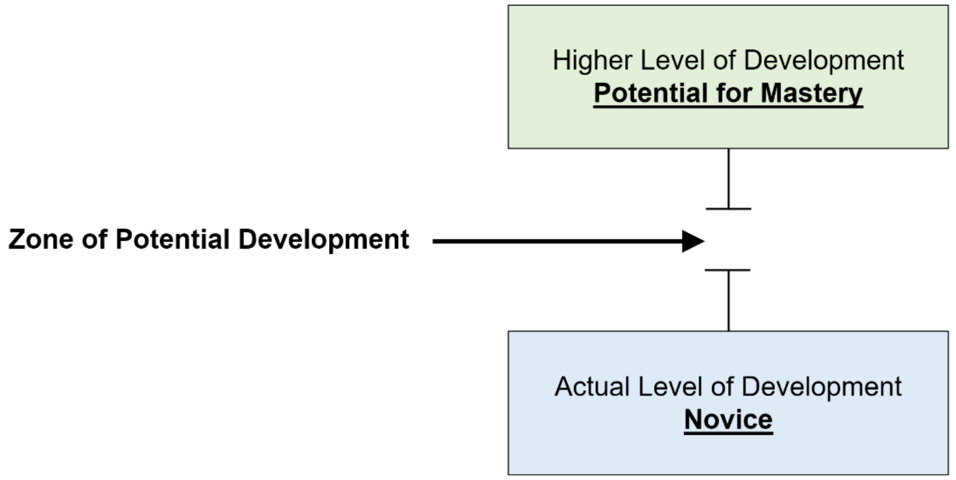


Note. Figure 6 is a visual description of Vygotsky's Zone of Proximal Development. It describes the set of skills a student can learn on their own (actual level of development), what they can learn with help (zone of proximal development), and those skills beyond a student's reach (zone of potential development). From "*What is the Zone of Proximal Development?"* by S. A. McLeod, 2019, *Simply Psychology.* © 2013 Steve Wheeler, University of Plymouth, all rights reserved.

The ZPD can be characterised simply as the space between the student's 'actual level of development' and the student's 'higher level of potential development' where they have the potential to achieve mastery (Stone, 1998). Figure 7 represents this as the gap that stands between both levels.

Figure 7

The Zone of Proximal Development – Novice to Master.



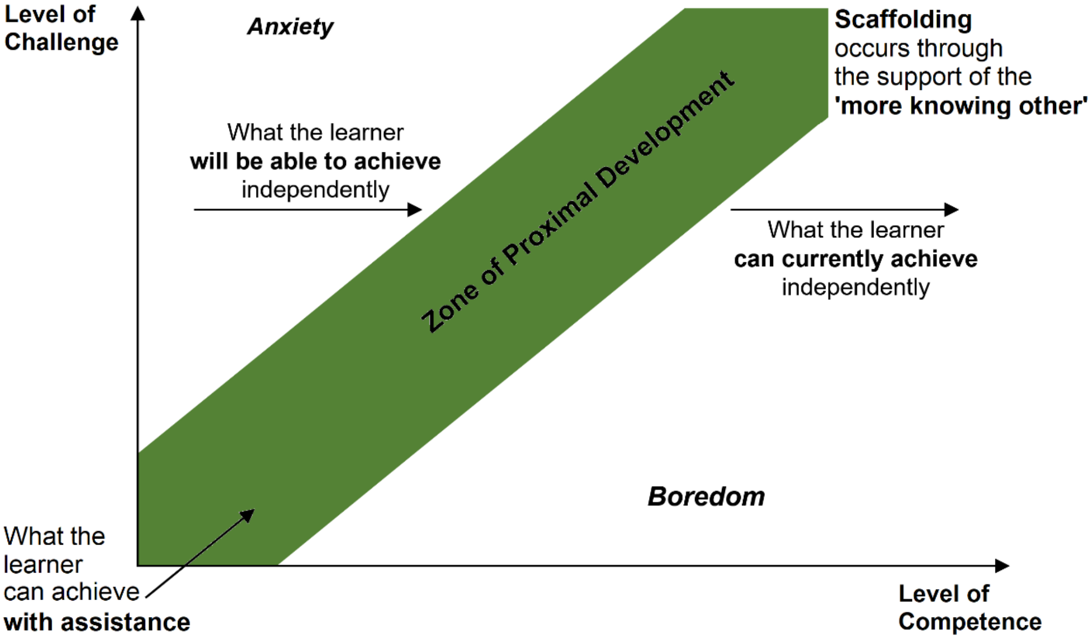
Note. Figure 7 graphically shows the space between a Novice student and their Potential for Mastery lies is the Zone of Potential Development.

Put differently, the ZPD lies between where a student is competent and where they are challenged. An example of a Year 1 mathematics concept that would lie inside the ZPD would be progressing from counting to 10 in single digits (1, 2, 3, 4, 5, 6, 7, 8, 9, 10) to skip counting to 10 (2, 4, 6, 8, 10). In this example, a Year 1 student's actual level of development would be as a master of counting to 10 in single digits. Using this prior ability and with the help of a parent (or competent adult) the student would work on developing their skills of skip counting to 10 within the ZPD until they achieve their goal, whereupon they reach a higher level of development.

The ZPD is an ideal way to model a student's beginning of formal education at Year 1 and Figure 8 graphically describes Vygotsky's Zone of Proximal Development as a ratio of the level of challenge versus the level of competence.

Figure 8

Graphing the Zone of Proximal Development.



Note. Figure 8 graphically describes Vygotsky's Zone of Proximal Development as a ratio of the level of challenge versus the level of competence. Adapted from Hill & Crévola, unpublished.

In this graphic the 'y' axis is represented by the level of challenge required of a learning exercise and the 'x' axis is represented by the level of competence a student has for a learning exercise. Successful teachers observe their students' development to confirm that each student is always learning within their level of challenge (Vygotsky, 1978, cited in Hill & Crévola, 1999). The greater the level of challenge required for a learning exercise the greater the level of anxiety experienced by the student. The greater the level of competence a student has for a learning exercise the greater the level of boredom experienced by a student. This graphic shows the ZPD to be the area of learning between these levels and the progression along the ZPD is where the learner achieves with assistance. The area from the border of the ZPD with student boredom is where a student can currently achieve independently and the border between the ZPD with student anxiety is where the student becomes able to able to achieve independently.

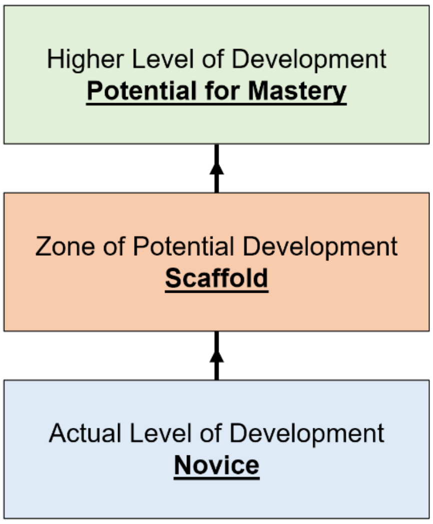
Wood et al. (1976) described the expert or 'more knowing other' in the ZPD as a facilitator of strategies and processes, and as a motivator providing enough support to contribute to the accomplishment of the student's learning objective, specifically highlighting critical issues, providing hints and reflective questions. Their more capable peer's role is as an enabler assisting the learner to bridge this gap between actual and potential learning outcomes – to encourage their move forward to higher learning. Examples of application of the ZPD include: learning to read individual words a student who struggles is more able to sound words out with direct feedback from a parent or teacher; learning addition a student who is frustrated on their own can ask questions of the teacher or parent and learn new strategies to reinforce knowledge and eventually add independently; learning to read text a student is more able to speed up the process with a teacher or parent who can advise word recognition strategies as and when they are needed; a child can seek direct advice for measuring from a parent who is present when cooking; a student learning to play tennis is able to progress from returning a ball to serving a ball with the help of a coach; and a student learning to paint is able to learn how to mix colours to form new colours with the help of their teacher.

2.2.3 Scaffolding

Wood et al. (1976) further developed Vygotsky's theories into their concept of 'scaffolding' as a method or theory of learning and teaching. Scaffolding occurs through the support of a 'more knowing other'. Figure 9 shows the scaffolding construct in the ZPD as providing the support allowing a student to lift from being a novice in an area of learning to having the potential for mastery in the area of learning.

Figure 9

The Scaffold Construct in the Zone of Proximal Development.

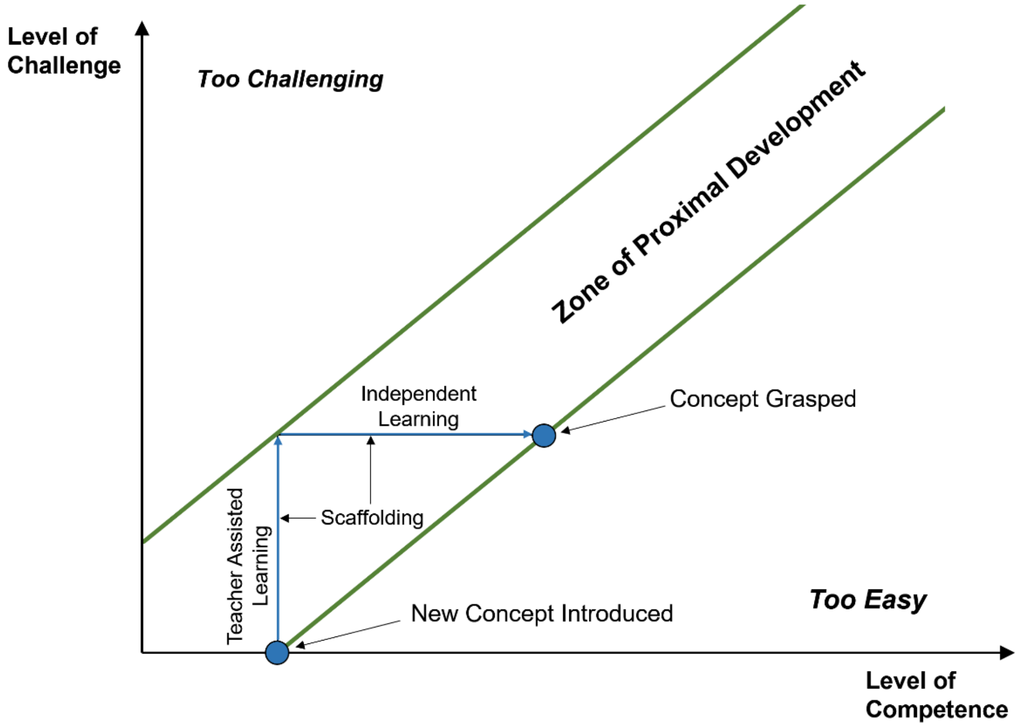


Mulvahill (2021), a former primary school teacher, listed her experience scaffolding learning to provide support for students: provide models to demonstrate; describe concepts in numerous ways; breakdown big tasks into smaller steps; give mini-lessons; use graphic planners; pace your teaching and slow down; include visual aids; introduce concept-specific terminology early; stimulate prior knowledge; encourage time to practice; check regularly that students understand; employ sentence starters; and teach students to assist each other. Alber (2011), an experienced teacher trainer, outlined scaffolding strategies to use with young students: pause, ask questions, pause, review; encourage show and tell; allow for time to talk; and pre-teach vocabulary. The Victoria Department of Education and Early Childhood Development (2004) summarized a set of scaffolding activities for teachers in their state: excavate; model; collaborate; guide; convince; notice, focus, probe; orient; reflect/review; extend; and apprentice. Garelick (2019) described scaffolding as a process where students are provided problems that increasingly challenge the student and for which temporary supports are removed. By doing this, students achieve proficiency at one level of problem-solving serving to both develop confidence and prepare them for a consequent rise in difficulty.

Figure 10 graphically describes the concept of scaffolding within a similar graph of Vygotsky's Zone of Proximal Development. Here it shows a new concept introduced and with a teacher's help the learner is scaffolded to becoming an independent learner.

Figure 10

Graphing Scaffolding within the Zone of Proximal Development.



Note. From "*Lev Vygotsky: Cognitive Development*.", Malndfair1, 2014, *Glogster*, *2020*.

Figure 10 explicates Hill and Crévola's graphical form further by showing scaffolding from where a new concept is introduced (Glogster, 2020). For example, a teacher might introduce the concept of skip counting upwards by twos to a student for the first time and where the teacher is confident that the student's prior knowledge of counting upwards by ones is sufficient to begin. By using some of the techniques identified by Mulvahill (2021), Alber (2011) and Garelick (2019) above, a teacher might use a visual aid such as a number line and start easy at the number 1 followed by front-loading the talk with a definition of the word 'skip' as 'to jump over' the number 2 and land on the number 3. By pausing and waiting to visually identify that the student 'gets' the process the teacher can then ask the student to follow the same process to skip count and see if they can skip the number 4 and land on the number 5. The teacher might ask the student to verbalise what is happening. If the student can't 'grasp' the process the teacher can repeat the initial process and wait until the student can follow on correctly. At this point the vertical accretion of teacher assisted learning along the axis of 'Challenge' takes place within the ZPD until the learning becomes too challenging for the learner. From there independent learning increments horizontally along the 'Competence' axis until the new concept is grasped by the learner. Without a new challenge the learner can become bored with repetition of the grasped concept as it becomes too easy. So, the teacher may then see if the student can continue up to the number 10 and if so, may ask that student to assist another student who is to learn the same process.

ACARA (2017) applied Vygotsky's (1978) zone of proximal development (Masters, 2013) and other available evidence to develop the learning structures for literacy and numeracy and curriculum progressions so that optimal learning can occur when learners are presented with challenges just beyond their current level of attainment. However, while these methods and theories based on Vygotsky have been known for nearly a century, there is no clear connection to them or their terms in the Curriculum for parents. While it is not necessary for parents to know the Vygotskian theories applied to education there are no simple parent guides, templates, or suggestions in the Curriculum such as those outlined by Mulvahill (2021), Alber (2011) and Garelick (2019) for teachers.

2.2.4 Feedback

Feedback may differ at different points of development. Feedback to students can take place in many ways such as oral, informal, formal, written, descriptive, evaluative, peer and self-assessed feedback. Chappuis (2012) describes three conditions, irrespective of the form of feedback, that need to be in place before presenting feedback: a) students need a clear idea of the planned learning; b) instructional activities need to associate directly with the proposed learning and students need to see that connection; and c) assessments need to be set up so that students can understand the results as gauges of what they have or have not yet learned. Feedback can take many forms, some are more effective than others, some are equally as effective as others and some overlap with each other (NSW Government, 2021). Research has shown that most Australian primary students respond positively to ‘effort’ feedback such as ‘you’ve been working really hard’; ‘you’re trying really hard’ as opposed to ‘ability’ feedback and in particular ‘private effort feedback’ such as ‘well done, you’re really clever; ‘wow, you’re a great student’(Burnett, 2002).

However, what is vitally important for Year 1 students is that the tone of the feedback, from both parent and teacher, is educative in nature, given in a timely manner, sensitive to the individual needs of the student, references a skill or specific knowledge, keeps students on track for achievement, concentrates on one ability, educates students on peer-to-peer feedback, gives genuine praise, and provides examples (Reynolds, 2013).

Feedback can take place either formatively or summatively within and around different levels of development. Vygotsky’s levels of development (McLeod, 2019) lend well to implementing both formative feedback (Panadero et al., 2018) and summative feedback (Macartney-Clark, 2018). Through scaffolded learning, formative feedback is ideally implemented within the ZPD (Ash & Levitt, 2017) and is where content can be appropriated by both the parent and their child (Newman et al., 1989) together within the ZPD (Gallimore & Tharpe, 1992). Formative feedback is considered the ‘most powerful factor in promoting learning in the 21st century’ (Black & Wiliam, 1998a; Black & Wiliam, 1998b; Johannesen, 2013; Nicol & Macfarlane-Dick, 2006).

Formative feedback for a child in the home setting generally takes place through continuous monitoring by their parent ‘while’ they are learning, based on scaffolded learning objectives (Stiggins, 2005), providing feedback on strengths, and assistance to overcome weak points (Yamtim & Wongwanich, 2014). In the class setting, Wiliam (2018) describes assessment as acting in a formative way where evidence of a student’s achievement is prompted, understood, and utilised by teachers, learners, or their peers to make choices regarding the next steps in instruction that are likely to be better than choices that might have been made without that evidence. Griffifth (2021) explored the available research on formative feedback and assessment within the teaching of primary school math in her doctoral thesis and argued that increasing evidence showed that parents should be added to Wiliam's (2018) definition as they play an integral part in the formative assessment process with student achievement increasing when parents are involved.

Summative feedback on the other hand takes place after learning has taken place, quite often as a way of testing (or summarising) how much learning has taken place (Yan & Cheng, 2015). Summative measurements can take place outside the ZPD at the 'actual level of development' as a pre-test or at the 'higher level of development' as a post-test. Summative judgments are often used by teachers for reporting purposes and are centred on a planned and focused selection of evidence of a student's learning compiled over a reporting period on which a total achievement standard is awarded (Queensland Studies Authority, 2015).

The Australian Curriculum, however, provides no obvious format or parental instruction for either of these forms of valuable feedback to be collaboratively exchangeable with their child and their teacher and based on sound learning objectives.

2.2.5 Mathematical Instructional Models

The subject of mathematics requires conceptual, procedural, and declarative knowledge (Miller, 2009), and these forms of knowledge can be developed through different models. Conceptual knowledge requires the understanding of relationships and connections among numbers. Procedural knowledge is built on the capability to follow the steps of a process in order to pursue the final answer. Declarative knowledge is the ability to solve mathematical problems precisely and automatically (Gibbs et al., 2018).

Models to improve mathematics instruction at the start of formal schooling have been well researched and it is critical they continue in order to build on each other (Gibbs et al., 2018). This continual improvement of technique is based on the fact that students who struggle in mathematics often have a limited grasp of the foundational processes of mathematics (Flores, Hinton, & Strozier, 2014; Mancl, Miller, & Kennedy, 2012; Powell, Fuchs, & Fuchs, 2013). Conceptual understanding of basic concepts lies at the heart of the problem of students falling behind as they progress through the Curriculum (Bryant, Bryant, Gersten, Scammacca, & Chavez, 2008; Gersten, Jordan, & Flojo, 2005; National Mathematics Advisory Panel, 2008).

2.2.6 Explicit Instructional Models

The National Mathematics Advisory Panel (2008) defines explicit instruction as a tactic whereby teachers provide clear demonstrations and models, multiple examples, and extensive practice opportunities, for solving problems. The panel recommended the use of extensive feedback from the teacher throughout the deployment of this tactic in order to improve student comprehension and success. Explicit instructional models are often applied through sequential and systemic portions of a lesson and examples include guided practice, independent practice, demonstrations, think aloud, and feedback (Mancl, Miller, & Kennedy, 2012).

2.2.7 Strategic Instructional Models

Strategy instructional models, however, concentrate on the procedures in solving problems (Montague, 2008). Through collaboration a parent can support their child with instruction strategies at home. By applying these strategies, a teacher or parent can give formative feedback at the time that their child is learning. Examples of strategy instruction models include verbal modelling, questioning, demonstrating, reminding, systemic explaining, step-by step prompting, multi-process instructing, assisting when needed, mnemonic cues, dialogue, and feedback (Swanson & Hoskyn, 1998). The most important elements of understanding numbers are quantity knowledge and counting (Kroesbergen, van't Noordende, & Kolkman, 2014).

Counting-on is an example of a procedural strategy to aid counting and help a student develop mental addition and subtraction and transition from the *counting-all* procedural strategy (Secada et al., 1983). *Counting-all* is the least effective strategy but is often a starting place for students where they make a concrete interpretation of a problem using a manipulative object of some kind or their fingers to show each addend, and then count all of the objects to find the total (Braun, 2015). The concept of *counting-on* starts with a number that a student knows and then they count-up or count-down from there. As an example, if the question is ‘5+4’ then the student is encouraged to start with the first number ‘5’ and then count-up out loud ‘4’ numbers. So, this would be ‘6, 7, 8, 9’ with the answer being ‘9’. Likewise, with the question ‘6-4’ the parent can show the student how to count-down by starting with the number ‘6’ and counting-down ‘4’ numbers. So, this would be ‘5, 4, 3, 2’ with the answer being ‘2’ (Secada et al., 1983). When counting-on is used verbally it also aids a student’s speech, literacy, and articulation of numbers and sequence. As a tactile aid, a teacher can show the student how to do this by using their fingers to count up or down. Also, a teacher can extend counting-on by using a number line and eventually encourage the student to do this process mentally so they can move to another more advanced procedural strategy such as skip-counting (Gibbs et al., 2018; Williams, 2018).

2.2.8 Concrete-Representational-Abstract (CRA) Teaching Sequence

The concrete-representational-abstract (CRA) teaching sequence is a well-researched method that uses components of both explicit and strategy instruction models (Peterson, Mercer & O’Shea, 1998). CRA instruction starts with concrete-level lessons where the teacher demonstrates how to represent and solve a problem by way of applying manipulatives (three dimensional objects) that support the ability/skill being explained. Following the teacher manipulative demonstration, the students are then given the manipulatives to engage and replicate the method with other problems and solutions.

Concrete/manipulative strategies employ tactile tools to help a student understand a concept or process through physical and visual engagement. Examples can include coins, blocks, or pens. Other examples can include geometry shapes made out of paper to demonstrate 2-dimensional shapes or 3-dimensional shapes such as cuboids or spheres. This engagement can provide ways for a parent to be active with their child in the discovery of new concepts and processes (Donovan & Alibali, 2021). A student’s early exploration of geometric shapes can act as a launch pad for more complicated math concepts (Pappas, 2020) and the construction of elaborate block buildings is associated with an improvement in math learning at preschool (Trawick-Smith et al., 2017). A good educational manipulative can also be seen as a toy and should be: active as opposed to passively watching a screen; engaging with no distractions; meaningful; and encourage social play (Hirsh-Pasek, 2021).

Once a teacher sees that a student can master a problem and solution using manipulatives, the sequence of instruction continues to representational-level lessons that involve the use of drawings or tallies to solve similar sorts of problems. Once mastery is gained at the representational-level, the sequence of instruction progresses to abstract-level lessons that involves solving problems using mathematical or numerical symbols only (Mancl, Miller, & Kennedy, 2012). For a successful application of the model, it is integral that the teacher provides clear connections between each of the component of the CRA teaching sequence in order to shift between each level of instruction (Witzel, Riccomini, & Schneider, 2008).

2.2.9 Imagery

A teacher can deploy imagery strategies with their students by helping them imagine things mentally through visual, auditory, or tactile methods or a combination of these methods. Where a parent has known their child all their life, they have an advantage in that they can remind their child of things that they know was either seen, heard or felt at different times in their child's life. These images can be used to create further images in their child's mind to elicit new mathematical and numerical constructs. An example of using imagery as a strategy to support a student in their zone of proximal development would be envisaging a set of weighing scales as an analogue for an algebraic equation (Beck, 2017).

Our brains are made up of 'distributed networks', and neuroimaging has shown that when we handle knowledge, different areas of our brains light up and communicate with each other (Boaler, et al., 2016). This brain activity is spread out across a widely distributed system, which includes two visual pathways: the ventral visual pathway and dorsal visual pathway, and when we work on mathematics neuroimaging has demonstrated that mathematical thinking is grounded in visual processing with these visual pathways lighting up (Boaler, et al., 2016).

2.2.10 Knowledge

In a similar way to using imagery strategies, a teacher can tap into the memory of their student by building on things that they know their student already knows. An example of this would be if a teacher knows that their student knows that ‘6+6’ equals ‘12’ then they could use this to explain that ‘2x6’ also equals ‘12’ (Larson & Rumsey, 2017). Utilising knowledge already gained and applying it while doing other things that children enjoy, such as making measurements while cooking or timing a long nature walk, is a very powerful way to engage mathematically with a child (Pappas, 2020).

2.3 Part 3: Educational Theories and Constructs for Measurement

Having discussed the relationship between teacher, parent, and student in Part 1, and the educational theories for application development in Part 2, it is necessary to consider in Part 3 some of the educational theories and constructs that shape the measurement methods that would be required of an online collaborative application. This includes defining learning objectives, defining ability groups, and measuring student proficiency against content and learning objectives.

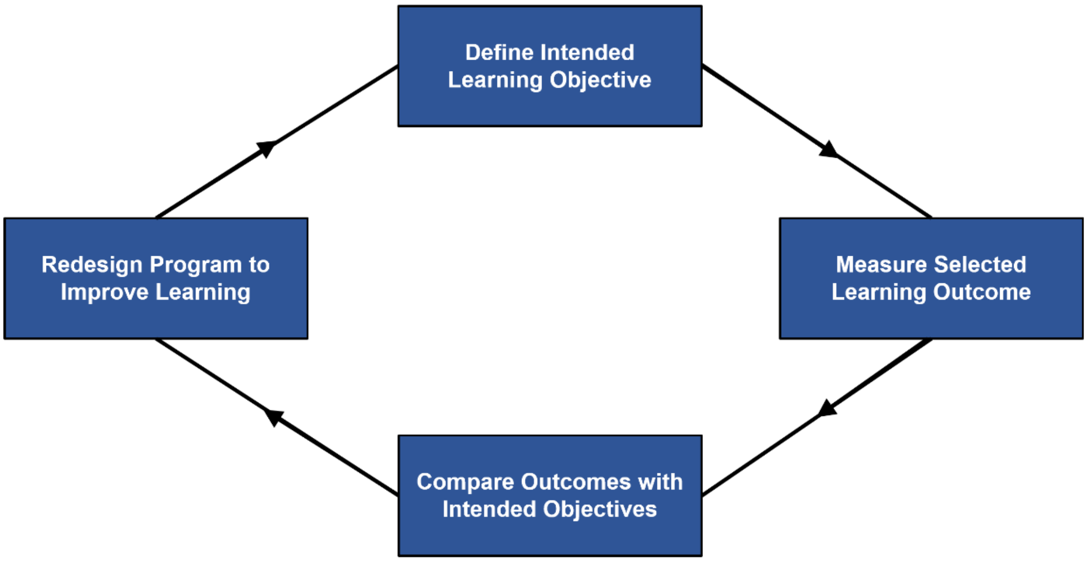
2.3.1 Defining Learning Objectives

Learning objectives can be simply defined as targets for students to aim for that are embodied in statements that clarify what students are expected to learn (McMillan, 2015). They offer clear descriptions to teachers of what a student must be able to do upon completion of a learning activity (Chatterjee & Corral, 2017) and indicate to students and parents what exactly will be required of the student and what they can expect to learn as a consequence of that requirement (Mitchell & Manzo, 2018). Clearly constructed learning objectives provide guiding statements for each learning encounter, connecting the intention with the reality within the learning event as well as to the assessment planned (Chatterjee & Corral, 2017).

Well-written learning objectives outline the knowledge, skills and/or attitude a student will gain from an educational activity and are measurable (Chatterjee & Corral, 2017). Figure 11 shows an assessment learning cycle (Diamond, 2018) that starts with a defined intended learning objective that has a measurable learning outcome. A program can then be redesigned to improve learning when the learning outcomes are compared to the intended objectives.

Figure 11

Assessment Learning Cycle.



Note. From "Clarifying Instructional Goals and Objectives" by R. Diamond, 2018, in R. Diamond (Ed.), *Designing and assessing courses and curricula: a practical guide*. © 2018 University of Connecticut Office of Institutional Research and Effectiveness, all rights reserved.

A quality learning objective should contain three things: a verb that describes an observable action; a description of the conditions under which the action takes place; and an acceptable level of performance (Diamond, 1998). While the Curriculum does not provide any simple and clear platform to parents as to how learning objectives are being applied to their child's learning at Year 1, Arreola (1998) lays out a definition of a learning objective as a measurement statement of what a student will be able to do once an instructional objective is complete. Arreola's (1998) model has four major components:

1. The condition that outlines the task to be performed by the student.
2. The action criteria for the student's performance.
3. The cognitive behaviour that is required of the student.

4. The standard that determines a positive learning outcome of the learning objective.

Table 1 shows how Arreola's (1998) definition of a learning objective is deconstructed in tabularised form.

Table 1

Arreola's (1998) Learning Objective Deconstruction.

Learning Objective	**Condition**	the condition that outlines the task to be performed by the student
	Action	the action criteria for the student's performance
	Behaviour	the cognitive behaviour that is required of the student
	Standard	the standard that determines a positive learning outcome of the learning objective

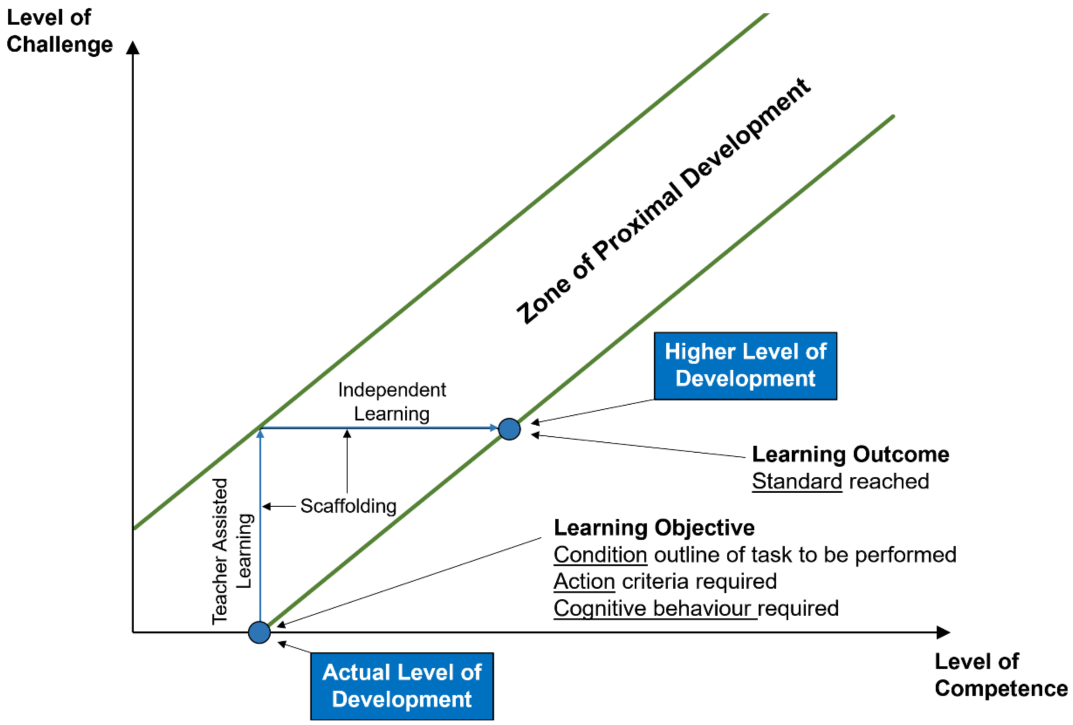
A defined model such as Arreola's (1998) provides a simple sequential and comprehensive process that identifies for a teacher (or parent) what is required for a student to progress. For year 1 mathematics, a structure such as this provides a clear method of instruction from a teacher to a parent, from the outset of a student's formal learning. This is because mathematics lends itself well to this kind of structure as it is, for the most part, sequential whereby students can move from one concept to the next after mastery, allowing them to tackle more difficult problems or learn harder concepts (Demme, 2014). Teaching and learning English, in comparison, needs to include: comprehension of the spoken form; developing an ability to use English in day-to-day life and real-life situations; understanding written text; and writing simple English to express ideas (IPL (2022).

The Curriculum does not explicitly or implicitly define or break down learning objectives into its components such as the model defined by Arreola (1998). The closest the Curriculum provides for mathematics at Year 1 is its Content Descriptions. As an example, the Content Description for Number and Place Value in the Curriculum is stated as: *Develop confidence with number sequences to and from 100 by ones from any starting point.* This Content Description does not provide a defined condition or action, and the behaviour required to *develop confidence* does not indicate a defined ability such as *count-forwards* or *count-backwards*.

Figure 12 shows how Arreola's (1998) definition of learning objectives track with Vygotsky's levels of development and alongside the teacher assisted scaffolding structure within the ZPD.

Figure 12

Overlaying Learning Objectives and Learning Outcomes with Scaffolding and the Zone of Proximal Development.



Note. From "*Lev Vygotsky: Cognitive Development*.", Malndfair1, 2014, *Glogster*, *2020*.

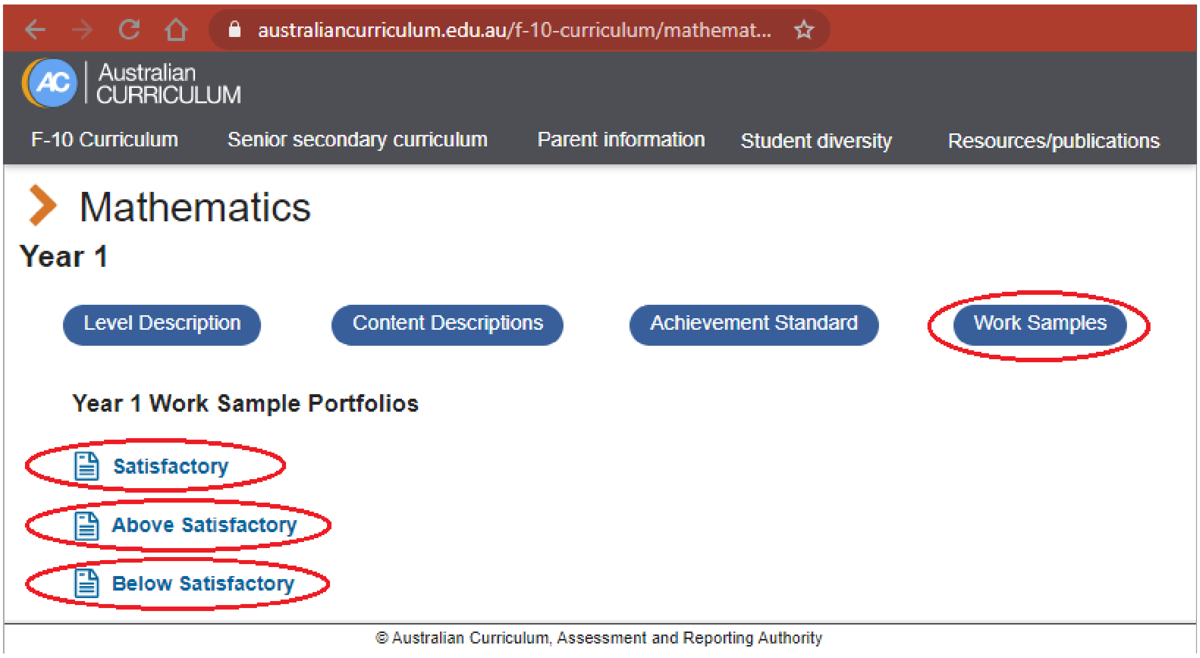
2.3.2 Defining Ability Groups

The Australian Curriculum adopts *performance measurement* through three levels of *ability grouping* that are veiled through *work sample portfolios* (see Appendix C, Figure C8). These are specified as: Above Satisfactory; Satisfactory; or Below Satisfactory. In theory, ability grouping provides improvements in student achievement by lowering the disparity in student ability levels (Slavin, 1980). Ability grouping means a teacher can deliver instruction that is neither too easy nor too hard for most students to be within the ZPD. Teachers can increase the pace and raise the level of teaching for high achievers (who can compete with other high achievers), offer more individual attention and repetition, and offer review for low achievers (who may benefit from not having to compete with the high achievers).

The Curriculum uses a form of ability grouping through example work sample portfolios: satisfactory; above satisfactory; and below satisfactory – see Figure 13.

Figure 13

Year 1 Ability Grouping in the Australian Mathematics Curriculum.



Note. Figure 13 shows ability group access points to 'Work Samples'. These are grouped in 'Satisfactory', 'Above Satisfactory' and 'Below Satisfactory' sections. From Australian Curriculum, 2021 (www.australiancurriculum.edu.au/f-10-curriculum/mathematics). © 2013 Australian Curriculum, Assessment and Reporting Authority, all rights reserved.

Figure 14 shows an example of a class of students that a teacher has grouped by ability. The * indicates that the teacher has positioned the student 'Mike' to be in the 'Below Satisfactory' ability grouping of their class of students.

Figure 14

Three Tier Ability Grouping of Students: Upper, Middle, Lower.

Class of Students
Andy
Cal
Deb
Jay
Jo
Mike*
Nic
Sam
Zoe

Class of Students	Ability Grouping
Cal	
Zoe	**Above Satisfactory**
Deb	
Sam	
Nic	**Satisfactory**
Jo	
Jay	
Mike*	**Below Satisfactory**
Andy	

Ability grouping has been a controversial issue in schools and education for a few decades (Glass, 2002), in large part because of the difficulty in applying it to an ever-changing level of student mastery and matching that to a varying curriculum. Furthermore, the Curriculum's use of the term 'satisfactory' as the axis for ability group categorisation of students is inherently teacher centric, arbitrary, and not for the positive consumption of students and parents.

2.3.3 Measuring Student Proficiency against Content and Objectives

Haladyna (2011) defines a test item as the basic unit of observation of any test and should be used as a measuring device, the intentions of which should describe numerically the degree of the amount of learning. Further, it should conform to uniform, standardised conditions. The Australian Curriculum provides a form of general measurement through the lens of the term *proficiency* that is buried within the *level description* (see Appendix C, Figure C3). The term and its application in the Curriculum have been framed upon the work of Kilpatrick et al. (2001) through four *proficiency strands*: understanding; fluency; problem-solving; and reasoning (see Appendix C, Figure C4). Understanding includes connecting names, numerals and quantities, and partitioning numbers in various ways. Fluency includes readily counting number in sequences forwards and backwards, locating numbers on a line and naming the days of the week. Problem-solving includes using materials to model authentic problems, giving and receiving directions to unfamiliar places, using familiar counting sequences to solve unfamiliar problems and discussing the reasonableness of the answer. Reasoning includes explaining direct and indirect comparisons of length using uniform informal units, justifying representations of data and explaining patterns that have been created.

The Curriculum asserts that the Proficiencies, as provided, reinforce the significance of working “mathematically within the content and describe how the content is explored or developed” – and further “to provide the language to build in the developmental aspects of the learning of mathematics” (see Appendix C, Figure C4). The Curriculum aims to use the achievement standards to reflect the content and encompass the Proficiencies.

2.4 Part 4: System Design and Development

Having discussed the relationship between teacher, parent, and student in Part 1, the educational theories for application development in Part 2, and the educational theories and constructs that shape the measurement methods in Part 3, it is necessary to consider in Part 4 an outline of the system design and system development considerations that might be needed to develop an online system.

2.4.1 System Design

Designing systems is a lot like imagining the future through nostalgia, because as humans we feel comfortable predicting what the future will be like by using our memories (Beck, 2017). However, linking system design with design theory is a necessary process to develop a solution that works for the ‘imaginer’ who possesses the idea and the ‘users’ of the solution. In 1986, Don Norman (Norman & Draper, 1986) introduced the term "user-centered design", which proposed the idea that designers should target their efforts at the people who will use the system that is to be introduced, leaving aside secondary considerations such as aesthetics. The resultant design involves streamlining the structure of tasks, making things obvious, getting the mapping right, utilising the powers of limitation, designing for error, and explaining affordances. Norman discerned that people are so adaptable that they are able to take on the whole burden of accommodation to an artifact, but that skilful designers make the majority of this burden seemingly disappear through adapting the artifact to the users.

In 2012 Kevin Systrom, the founder of Instagram, continued this concept of user-centered design as the process of iterative and continual measure of customer/user happiness (Fridman, 2021c). Systrom and his senior development team aimed towards product-market fit and practiced user-centered design to make each design iteration more meaningful by including users so that their thoughts and feelings were actually considered in the design process (Sizemore, 2018). Systrom considered apps to be in fact designs, made up of numerous shifting parts for people with specific needs and wants and constantly talked personally to Instagram users in order to gain an outside perspective on what needed to be improved. As an example, one of Systrom's key findings was that Burbn (Instagram's precursor) users did not care much for the 'check-in' feature of the app, but really enjoyed using its 'photo-sharing' capabilities. As a consequence, Systrom identified users' needs and wants and trimmed down the app to be primarily about photo-sharing. Stevenson (2020) identified with Systrom's philosophy of design thinking, also known as human-centered design, as a method that puts the user first by creating a design for a specific intended audience through five stages: empathising to understand likes and dislikes; defining the problem; brainstorming with the development team; prototyping to develop a tangible sense of what the product or service will look like; and testing with the intended audience.

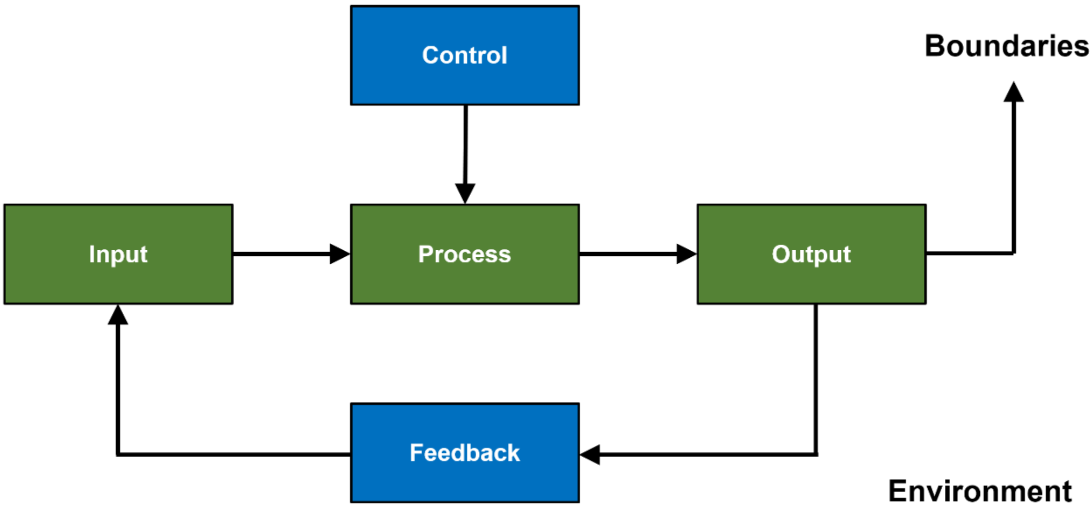
In contrast, Geis & Birkhofer (2010) proposed five elementary categories of design models: algorithmic models that define the state of design entities and their transformation between the parameters of these entities; strategic models that support planning, organization and process control; tactical models that implement methods to address actual situations and needs; operative models that describe the process of problem solving; and reasoning models to understand and explain the processes and actions being executed. More specifically, Jones & Gregor (2007) distinguished eight separate components for a successful design: purpose and scope; constructs; principles of form and function; artifact mutability; testable propositions; justificatory knowledge; principles of implementation; and an expository instantiation.

2.4.2 System Development

In parallel to system design is the more structured approach of the traditional Input-Process-Output (IPO) system development model - see Figure 15.

Figure 15

Input Process Output.



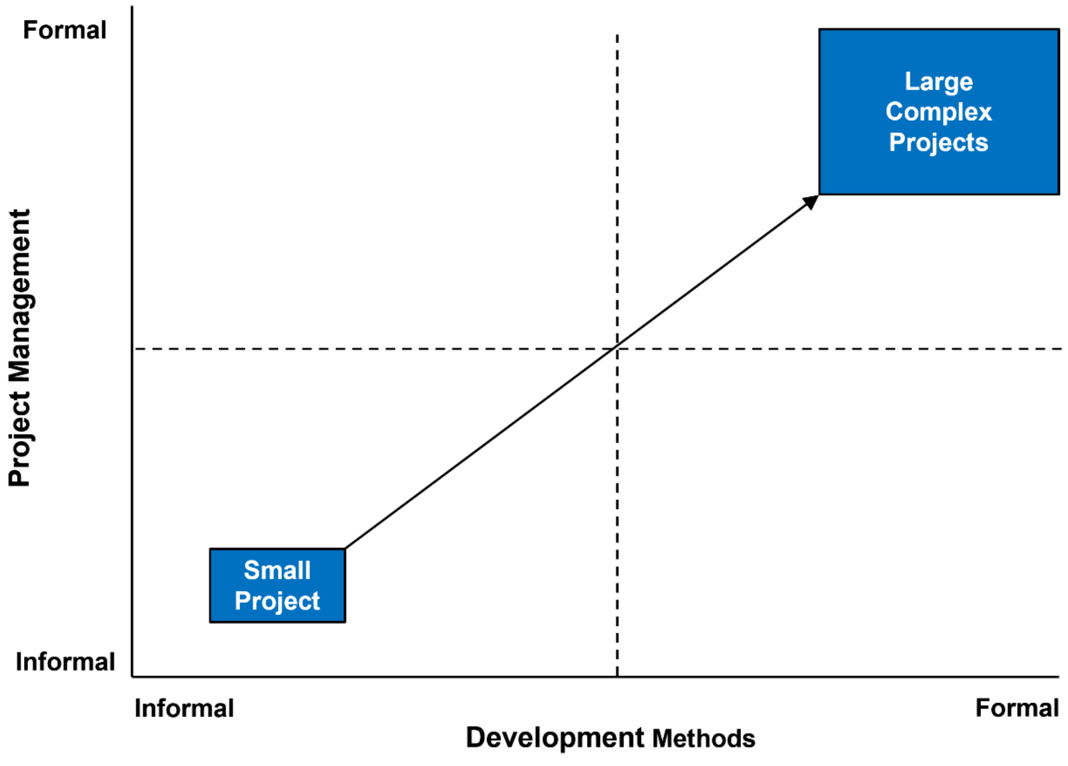
Note. From "*System analysis and design.*" TutorialsPoint, 2021, p. 2. *TutorialsPoint*.

The IPO model initiates with inputs, works through processes, and produces outputs. Control mechanisms usually embed within the process and outcomes of the output feedback information to potentially modify inputs or processes for the system to cycle. Variations of the IPO model cater for specific market sectors and engineering scenarios; however, Johnson et al. (2012) argue that significant theories of systems engineering need to be developed to deal with important questions within the discipline (Hall & Rapanotti, 2017). Jackson (2015) specifically views software design in terms of concepts, for both the user and the developer, with refinement being the central engineering activity of software design. For example, a programmer developing code in text form would have to be mindful of the wider concept of what is being created. The concept, for the programmer, is a structure invented to provide an articulation of the direct outcomes of actions in a complex system. Kapor (1996) advocated for software design to be distinguished from pure programming reasoning that just as buildings need architects, so software needs designers.

However, the problem of scale is encountered in all software and online developments. Figure 16 shows the continuum from a small project that can be managed and developed informally to large complex projects that require more formal project management and development (Jalote, 2005).

Figure 16

The Problem of Scale.



Note. From "*An integrated approach to software engineering.*" Jalote, 2005, p. 9. *Springer*.

Scaling problems with a technology development, such as an online collaborative homework system, could include growing an employee workforce to meet demand, duplication or replication of systems, code efficiency improvements or code rewrite, adding layers of management, transferring best practices across networks of teachers. Essentially, these problems all face the difficulty of spreading something good from those who have it to those that do not (Sutton, 2013).

2.5 Part 5: Purpose of this Study and Research Question

Discussion of the relationship between teacher, parent, and student (Part 1), the educational theories for application development (Part 2), the educational theories and constructs that shape the measurement methods (Part 3), and an outline of the system design and system development considerations that might be needed to develop an online system (Part 4) provides a foundation to consider the purpose of this study and the research question.

The overarching goal of this research is as a preface for a further study where the Research laid the foundation/direction to produce a feature specification that could be developed and utilised by Australian teachers, parents, and students. This Masters study will be focused on understanding the teacher perspective of homework learning and its potential for online collaboration with parents and more generally around mathematics students advancing at Year 1.

This literature review identifies a list of concepts including the parent-teacher-student relationships, the Curriculum, Vygotsky and social development theory, scaffolding, feedback, mathematical instructional models, the concrete-representational-abstract (CRA) teaching sequence, learning objectives, ability groups, proficiencies, system design and development. This list of concepts are potential collaborative solutions that might help to address the problems of Australian’s Mathematics non-optimal and expensive performance compared with OECD nations. Consequently, collaborative support solutions must:

- engage with students and provide timely feedback (Chan et al., 2013; Klem & Connell, 2004)
- must be clear and deliver through high-quality content
- must provide extension learning as well as practice and preparation (Rosário et al., 2015)
- include parents (Garcia, 2000; Henderson & Mapp, 2002;

LaRocque et al., 2011).

The literature review also suggests that the way the Australian Year 1 Mathematics Curriculum is presented, through its structure and language, renders it impenetrable for parents. An understanding, therefore, of what the Curriculum is and what it could be, with the aim of identifying the defining features of an online collaborative support system, could positively contribute towards bridging the gap between the language teachers use and what parents could generally understand, to allow their children to flourish in the homework setting. The main research question therefore is:

What features are necessary to design an online collaborative homework support system for Australian Year 1 Mathematics?

In particular, this study will answer further sub-research questions:

1. Barriers - what barriers exist that could impede implementation of the features?
2. Interface – how could the features interface between the Curriculum and users to overcome the barriers?
3. Existing Applications - what Year 1 mathematics applications are currently available, either in the Curriculum or stand-alone, that are used by teachers that contain any of the features?

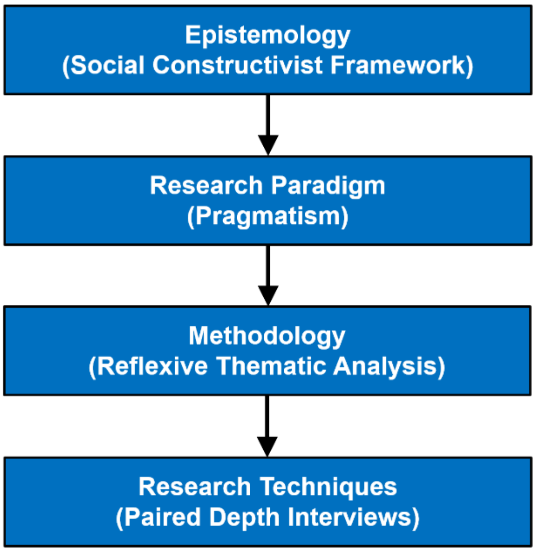
3. METHODOLOGY AND RESEARCH DESIGN

Introduction

To identify the features necessary to design an online collaborative homework support system for Australian Year 1 Mathematics from a teacher perspective the Researcher has adopted an epistemological viewpoint that is discussed in Section 3.1. Following this an explanation is provided as to why a pragmatic paradigm suits this project's consequence in Section 3.2. A preview of the way the data is going to be analysed is provided in Section 3.3 through Braun and Clarke's Reflexive Thematic Analysis (Braun & Clarke, 2021). Determining and justifying the participant group is discussed in Section 3.4 and groups size in Section 3.5. A description of the participant inclusion/exclusion criteria is presented in Section 3.6 and an overview of paired depth interviews is presented in Section 3.7. Ethical limitations are discussed in Section 3.8 and limitations in Section 3.9. The interviews and questions are provided in Section 3.10 as is the intended outputs of the data analysis in Section 3.11. Figure 17 shows the sequence of alignment between epistemological perspective, research paradigm, methodology, and research techniques.

Figure 17

Alignment between Epistemological Perspective, Research Paradigm, Methodology, and Research Techniques.



3.1 Epistemological Perspective

Philosophy begins in a kind of wonder or puzzlement (Aristotle 384-322 BC) and through one branch of philosophy, epistemology, this research seeks to understand what is actually taking place in the transference of mathematics learning at Year 1 between the class and home in order to identify the defining features of an online collaborative support system. The term Epistemology is derived from the Greek words, “episteme” and “logos”. “Episteme” can be translated to mean “knowledge” or “understanding”, and “logos” translated as “argument” or “reason”. Epistemology specifically studies knowledge and what we believe, through a parallax of truth, belief, and justification conditions. If all three conditions are met of a given claim, then we can assert we have knowledge of that claim. Historically, Plato’s adopted epistemology was to try and understand what it was to know, whereas more modern applications of epistemology seek to understand how evidence rationally constrains our degrees of confidence (Stanford Encyclopedia of Philosophy, 2005).

From an epistemological perspective, this research seeks to apply a social constructivist framework pursuing understanding of what is true and whether patterns and correlations that contain personal biases and leanings are true and justified to form a practical answer to the research question. The origins of this study stem from the author’s career in the education software sector. A key proponent of personal discovery has been that even though this study may look like a combination of education and technology, it is rather a study of the three-way relationship that exists between the participants – students, teachers, parents in the homework setting. Consequently, talking about one relationship is difficult without reference to the others. These relationships have been observed subjectively by the author through his career experience and observing the difficulties his children experienced through their primary school years. Based on these experiences, the researcher proposes that any homework collaboration solution or measurement is likely considered as an impact to all three relationships.

3.2 Research Paradigm

In the science of social research, the term “paradigm” refers to the basic set of beliefs of the researcher that defines their worldview and guides their actions (Kaushik & Walsh, 2019). Pragmatism is a deconstructive paradigm that promotes the use of mixed methods in research to focus on ‘what works’ as truth (Tashakkori & Teddlie, 2003) as opposed to determining, “the contentious issues of truth and reality” (Feilzer, 2009) in and of themselves. Despite this, pragmatists do subscribe to a reality, except that it is in constant flux based on our actions. As one of the founders of pragmatism, John Dewey (1859-1952) called this attempt to find a reality outside of ourselves a "spectator theory" of knowledge (Kulp, 1992, p. 211). Pragmatists see actions as having outcomes that are often quite predictable - and our lives are built around the experiences that link these actions and their outcomes (Morgan, 2014).

The aim of this study is to reach forward to a *consequence*. This consequence being *improvement* and intended for the benefit of the participants. This bearing of *consequence* is a foundational underpinning of a *pragmatic worldview* (Cherryholmes, 1992) and Peirce’s 1905 pragmatic maxim nicely lays a foundation for this worldview:

> The method prescribed in the [pragmatic] maxim is to trace out in the imagination the conceivable practical consequences for deliberate, self-controlled conduct - of the affirmation or denial of the concept; and the assertion of the maxim is that herein lies the *whole* of the purport of the word, the *entire* concept. (Peirce, 1905, p. 1476)

Cherryholmes further suggests that these consequences “cannot be estimated outside of context” (Cherryholmes, 1994, p.17). What this means for the current study is that answers to the research question must be directed towards these consequences through the identification of both context and aesthetic – or else failure will head off at the start of a design’s implementation (Cherryholmes, 1994, p.17). While such aesthetics should be made up of ordinary artistic experiences, adherence to Peirce’s Maxim would contend that these would be traced out in the *imagination* specifically of the participants (Dewey, 1934). The very nature of answering the call to develop *new ways of doing things* has been the driving force behind our new internet society. Whether this has been a result of the pursuit of profit or the intrinsic value of the endeavour in itself (Cherryholmes, 1994), the resultant vector has been one of going forward – to reach a purposeful consequence. The causal connection from this pragmatic worldview to a qualitative research design is to solve a problem for the participants that has real-world value. This value would invoke investigation utilising qualitative methods. With this framework in mind, it is clearer to see that if the consequences do not *look like* what the participants would expect – then it would a fruitless vessel, void of value to the participants.

3.3 Data Analysis – Thematic Analysis

The epistemological perspective that this research seeks to apply is through a social constructivist framework, pursuing understanding of what is true and whether patterns and correlations that contain personal biases and leanings are true and justified to form a practical answer to the research question. Braun and Clarke's (2006) Thematic Analysis is an approach that fits wthin this epistomelogical social constructivist framework application by aiming to make meaning of the experiences of the participant teachers in their work contexts. Virginia Braun a professor (Psychology) at the University of Auckland, New Zealand, and Victoria Clarke an associate professor (Health and Social Sciences) at the University of the West of England Bristol, are two well published and cited experts in methodology research in particular the redefining of their form of Thematic Analysis since their seminal paper of 2006 on the subject.

Thematic Analysis is clearly distinguished from other qualitative approaches (grounded theory or narrative analysis for example) because it is more analogous to a 'method' than a 'methodology'. Braun and Clarke (2021) describe a method as, "a transtheoretical tool or technique," and a methodology as, "a theoretically informed framework for research" (p.1). They go on to quote Chamberlain (2012) who notes that that approaches like grounded theory and narrative analysis have been labelled as "off-the-shelf" methodologies (Braun & Clarke, 2021, p. 1) because of the way they comprise a theoretical framework, both analytic techniques and philosophical assumptions, and lean towards particular types of participant selection, methods of collecting data, procedures for quality, and research questions

(Braun & Clarke, 2021). Thematic Analysis, on the other hand, has been argued by some qualitative methodologists to be more demanding of a researcher's conceptual design and design thinking when compared to using 'off-the-shelf' methodologies (McLeod, 2015; Willig, 2013). Therefore, for context, the Researcher's subjective position must be held to account at the forefront of this study.

The Researcher's principal reason for undertaking this study has been a pragmatic continuation of a career developing software in the education sector, with pragmatism being the driver to eventually develop a workable solution for teachers, parents, and students. While that experience was in the secondary and tertiary education sector, the Researcher has aims for this study's findings to inform the development of an online collaborative homework solution for the Australian Mathematics primary school sector through further academic research. While the Researcher is not coming into this study 'from scratch', his twenty-year career experience lacks any interface with the primary sector, thereby allowing him to start as a 'novice' of the methods that are utilised in that sector - a humble 'cap-in-hand' investigator. For this reason, Thematic Analysis is a good option to choose for this study's data analysis, in that while it might not be an "easy option" (Willig, 2013, p. 66) it is "a good choice for researchers who feel confident that they know what they are trying to achieve" (McLeod, 2015 p. 147). Braun and Clarke's (2006) original six steps approach to Thematic Analysis:

1. Familiarising yourself with your data.
2. Generating initial codes.
3. Searching for themes.
4. Reviewing themes.
5. Defining and naming themes.
6. Producing the report.

Table 2 shows Braun and Clarke's (2006) original six steps outlining their approach to Thematic Analysis.

Table 2

Original Steps of Braun and Clarke’s (2006) Thematic Analysis.

Thematic Analysis Steps of Braun & Clarke (2006)	
1	Familiarising yourself with your data.
2	Generating initial codes
3	Searching for themes.
4	Reviewing themes.
5	Defining and naming themes.
6	Producing the report.

3.3.1 Reflexive Thematic Analysis

More specifically, Braun and Clarke’s (2006, 2012, 2019a) *Reflexive* form of Thematic Analysis lends itself perfectly to the conceptual design and design thinking required of this study. Braun and Clarke (2021) summarised the core assumptions of reflexive Thematic Analysis across 10 points and Table 3 outline these core assumptions more directly and in more detail.

Table 3

Braun & Clarke's (2021) Core Assumptions of Reflexive Thematic Analysis.

Braun & Clarke's (2021) Core Assumptions of *Reflexive* Thematic Analysis	
1	Researcher subjectivity is the primary "tool" for Reflexive Thematic Analysis.
2	Analysis and interpretation of data cannot be accurate or objective, but can be weaker (e.g., underdeveloped, unconvincing, thin, and superficial, shallow) or stronger (e.g., compelling, insightful, thoughtful, rich, complex, deep, nuanced).
3	Good quality coding and themes result from dual processes of immersion or depth of engagement, and distancing, allowing time and space for reflection and for insight and inspiration to develop.
4	A single coder/analyst is typical in Reflexive Thematic Analysis.
5	Themes are analytic outputs, not inputs, and are developed after coding and from codes.
6	Themes are patterns of meaning anchored by a shared idea or concept (central organizing concept) not summaries of meaning related to a topic.
7	Themes are conceptualized as produced by the researcher through their systematic analytic engagement with the data set, and all they bring to the data in terms of personal positioning and metatheoretical perspectives.
8	Data analysis is always underpinned by theoretical assumptions, and these assumptions need to be acknowledged and reflected on.
9	Reflexivity, the researchers' insight into, and articulation of, their generative role in research, is key to good quality analysis. Researchers must strive to "own their perspectives" (Elliott et al., 1999).
10	Data analysis is conceptualized as an art, not a science; creativity is central to the process, within a framework of rigor.

Note. From "*Conceptual and Design Thinking for Thematic Analysis*.", Braun, V., & Clarke, V., 2021, *Qualitative Psychology, (online)*, p. 6-7, *2021*.

Braun and Clarke's (2017) *Reflexive Thematic Analysis* is a perfect vehicle to identify, analyse, and describe "patterns of meaning ('themes') within qualitative data” (Braun & Clarke, 2017, p. 297) without being, “wedded to any pre-existing theoretical framework” (Braun & Clarke, 2006, p. 81). Essentially, the themes will be the voices of the participants - the teachers - along with the analysis of each theme to provide a “detailed and nuanced account of one particular theme, or group of themes, within the data” (Braun & Clarke, 2006, p. 83). Adopting Reflexive Thematic Analysis for this study underscores the predictable subjectivity of data coding and analysis, and the Researcher’s working function in coding and theme generation (e.g., Gleeson, 2011; Hayes, 2000). This is further enhanced considering the Researcher’s career, his observance of the historical growth of technology spanning four generations, and his observance of his own three children having already moved through the Primary schooling years.

Reflexive approaches prioritize the values of what Braun and Clarke refer to as “Big Q” qualitative paradigms that involve “both qualitative data, and values and practices embedded in a qualitative paradigm” (Braun & Clarke, 2021, p. 4). Valuing the ‘Big Q’ qualitative paradigms means emphasising the Researcher’s inevitable subjective data coding and analysis (Gleeson, 2011; Hayes, 2000). Gough & Madill (2012) espoused that subjectivity is not a problem to be controlled or managed, rather it is a resource for research. Braun & Clarke (2021, p.6) identify the concept of “researcher bias” within reflexive thematic analysis inferring the possibility that unbiased or objective knowledge generation, is incompatible with reflexive thematic analysis in that knowledge generation is inherently subjective and situated. This means that this study must address conceptual design and design thinking by making an argument that these key conceptual foundations of the Reflexive approach sit within a social constructionist framework and will ‘fit’ with the intention of this study’s anticipated conclusion.

3.3.2 Reflexive Thematic Analysis and Conceptual Design

Braun and Clarke’s (2019a) approach to Reflexive Thematic Analysis was borne of a critique and rejection of the values underlying (post) positivist Thematic Analysis. They argue the position that Thematic Analysis, and even more generally qualitative analysis (e.g., Morrow, 2007), is frequently likened with studies of phenomenology (e.g., Guest et al., 2012; Joffe, 2012), and subjectivity and lived experiences (e.g., Flick, 2014). They assert that, as they themselves are researchers “schooled in social constructionism” (Braun & Clarke, 2021, p. 6), Thematic Analysis, and qualitative research, should be viewed beyond any boundaries of question for experiential phenomena to social processes, and/or the social construction of meaning. They position themselves as “relatively unique” (Braun & Clarke, 2021, p. 6) within the community of Thematic Analysis authors in that they carve out a distinction between experiential and constructionist orientations to Thematic Analysis (see also King, 2012; King & Brooks, 2017).

Applied to this study, the experiential distinction of Reflexive Thematic Analysis is a good ‘fit’ for the prospective teacher participants. Following Braun and Clarke’s (2021) argument, this is because experiential Thematic Analysis, which includes Reflexive Thematic Analysis when used in experiential orientations, is a journey of exploration to discover the participant’s ‘truth’ situated within the context of their experiences (teachers), perspectives (career experience), and behaviours (differing teaching methods). Furthermore, they expound that experiential Thematic Analysis is usually buttressed by some kind of realist (naïve and critical) ontology (Maxwell, 2012) of which the naïve realism form suits this study well. This is because it sees perception as essentially involving a relation between subjects and their environments (Fish, W., 2017) and language as being conceptualised (Reicher, 2000), and this would reveal the true nature of each participant’s contextually situated unique realities or truths (Braun & Clarke, 2013). Importantly for this study, because the Researcher brings their own philosophical metatheoretical assumptions to the analysis, induction in its purest form becomes impossible. Rather, an inductive orientation in this study is better understood as “grounded” in data (Braun & Clarke, 2021, p. 6), moving from specific observations to broader generalizations and theories (Trochim, 2021). Indeed, those philosophical metatheoretical assumptions could well be brought into this study through the overlap between the Researcher’s career experience in developing mathematics software for high-school education.

Reflexive Thematic Analysis requires no single starting point for, and route through, research design. In this study the Researcher's starting point was to develop a practical solution within the education sector from where his experience was drawn. A coherent design, or methodological integrity (Levitt et al., 2017), is a key principle in Thematic Analysis research because there are few inherent limits or prescriptions in research design for Thematic Analysis research (Braun & Clarke, 2013; Willig, 2013). To maintain a sense of coherence in this study, the Researcher has made abundant use of tabularised structures wherever possible, which is clearly referred to in text and notes.

3.3.3 Reflexive Thematic Analysis to be applied in this Study

The intention of this study is that the themes within the data will be identified through a theoretical analysis at a semantic level that will be coded drawing upon the Researcher's understanding of issues in the mathematics, education technology, and homework setting. In practice, the design of this study follows the most recent articulation of data engagement, coding, and theme development, encapsulated within the six phases of Reflexive Thematic Analysis (Braun & Clarke, 2020). Table 4 shows these phases: data familiarisation and writing familiarisation notes; systematic data coding; generating initial themes from coded and collated data; developing and reviewing themes; refining, defining and naming themes; and writing the report. These phases will be outlined in more detail in Section 4.

Table 4

Six Phases of Braun and Clarke's (2020) Reflexive Thematic Analysis.

Six Phases of Braun & Clarke's (2020) *Reflexive* Thematic Analysis	
1	Data familiarisation and writing familiarisation notes (familiarity with the data from the transcriptions).
2	Systematic data coding (generating codes of interesting features of the data in a systematic fashion across the entire data set).
3	Generating initial themes from coded and collated data (searching for themes and collation of data into the themes).
4	Developing and reviewing themes (reviewing and checking if the themes work in relation to the coded extracts and the entire data set to generate a thematic 'map' of the analysis).
5	Refining, defining and naming themes.
6	Writing the report.

3.4 Interviews and Interview Questions

The nine interview questions in Table 5 followed the line of understanding explored in the literature review. While these started off as *fixed,* they were not designed to inhibit development throughout the course of the research and should be seen as a "starting point" enabling the participants to expand, concentrate, or even shift in focus (Braun & Clarke, 2021) within the interview. The questions in Table 5 were used to draw out the Participant's voices. While the interview questions were designed to follow a format, they were also open-ended, providing the Participants scope to determine sub-elements they considered most relevant (Bowden et al., 2002). Subsequent questions encouraged Participants to develop or clarify as fully as possible their understandings and experiences. To maintain adaptation to Reflexive Thematic Analysis, priority was given to maintaining a more accommodating and liquid approach to interviewing that more closely resembled the "messier" tide of real-world conversation, whereby the interviewer hones-in on co-construction of meaning with the Participants. The objective was to be “on target while hanging loose” (Rubin & Rubin, 1995, p. 42). Interviews were intended to take from 30-40 minutes to give time for the Participants to fully define their understandings and experiences (Trigwell, 2000). Interviews were then transcribed and analysed using NVIVO, Microsoft Excel, and Microsoft Word software to code themes that were found following immersion in the data.

Table 5

Interview Questions.

Q.1	**Parental Involvement with their Child at Home** Describe any technologies that you think could include parents to help students engage in mathematics homework - and connects to you and the Curriculum.
Q.2	**Student Engagement** Describe how any of these technologies could engage students in mathematics homework - with you, their parent and the Curriculum.
Q.3	**Positive Parent-Student Relationship** Describe how any of these technologies could promote (or deter) a positive parent-student relationship.
Q.4	**Student-Teacher Collaboration** Describe how any of these technologies could support collaboration between you and your student in their mathematics homework.
Q.5	**Positive Attitudes towards Technology** Describe your attitude towards technology being used for Mathematics homework that allows your students to collaborate with you and involve parents.
Q.6	**Feedback** How could technology interface between you, a student and their parent and provide feedback as a student develops Mathematical learning in their homework.
Q.7	**Measuring Student Proficiency against Content and Objectives** If technology could measure a student’s understanding, fluency, problem-solving and reasoning in their Mathematics homework against learning objectives would this be useful? Why?
Q.8	**Measuring Performance** If technology could measure a student’s performance in their Mathematics homework against other students would this be useful? Why?
Q.9	**Learning Technologies aligned with the Australian Curriculum** How easy/difficult is the Australian Mathematics Curriculum to navigate?

3.5 Determining and Justifying Participant Group

The flexibility of Reflexive Thematic Analysis provides for few inherent constraints around data collection methods or sources. The emphasis in Thematic Analysis in general is on themes and patterns of meaning across cases, as opposed to meaning within individual cases, with the participant group large enough to defend the claims relating to patterned meaning. However, Reflexive Thematic Analysis has no precise group selection requirements regarding how the participant group is selected – what is frequently identified as the *sampling* method or strategy (Braun & Clarke, 2021). Robinson (2014) includes four useful guide points in selecting and generating participant groups in Reflexive Thematic Analysis including: defining a "sampling universe" using inclusion and exclusion criteria; shaping a sample size by reflecting on what is ideal (accordant with the purpose of research, analytic orientation, and theoretical underpinnings) and what is practical (e.g., time, resources, norms of the local participant context); develop a sampling strategy for selecting participants; and recruit participants from the sampling universe. In this study, the "sampling universe" is primary school teachers including those who have taught year 1 within the last three years and excludes teachers not currently employed by a school. Capturing some of the range and diversity of meaning within the "population" rather than providing some "quantified representation" of it is the overall aim of qualitative research performed within qualitative paradigms (Gaskell, 2000). This allows for an in-depth investigation of the research question in order to exploit the prospect for "transferability" of results (Spencer et al., 2003).

Purposive sampling, therefore, is ideally suited for this study because it involves deliberately selecting "information-rich" cases (Patton, 2015) that have the potential to maximise understanding of what is under investigation (Braun & Clarke, 2021, p. 12). In the case of purposive sampling, the selected participants can be homogenous or heterogenous within the constituency, or somewhere in between. However, what matters most for Reflexive Thematic Analysis design coherence, is that the Researcher proves: an understanding of the "sampling" strategy; why it has been chosen; its strengths and limitations; and "articulate how and why it provides a set of data to meaningfully address the research question" (Braun & Clarke, 2021, p. 12).

3.6 Determining and Justifying Participant Group Size

For groups that consist of fewer than 10 participants, Braun and Clarke (2021) note that homogeneity may help to enable theme development. Examples of such homogeneity include demographics, experience, and location (Robinson, 2014). Braun and Clarke (2021) further note with regards to participant group size, that studies with concrete deadlines, such as this one, need to balance a data set with enough breadth and depth to provide validity in the analysis. Braun and Clarke (2021) continue to discern that collecting data past saturation, the point where further added information from data collection no longer adds new information to the data set (Malterud et al., 2016), stops making sense and sets the themes as “waiting to be discovered”, which, as set out in this thesis, is not how Reflexive Thematic Analysis conceptualises themes. Braun and Clarke (2021) argue that there can always be the capacity for new understandings (Mason, 2010) established through ongoing data engagement or from studying the data from different points of view (Braun & Clarke, 2021). They concede that the initially provided participant group may need to be smaller during data collection or following the initial phases of the analytic process (Braun & Clarke, 2021), which may be pertinent for this study considering not only the homogeneity of the teacher/participant demographics, experience, and location, but also the depth of data collected through qualitative paired-depth interviews.

3.7 Participant Recruitment

The teacher participants initially recruited were from the Researcher’s personal contacts of primary school teachers, with the balance of participants from direct contact requests with school principals. The range of teacher participants included a variety of different teaching styles and ages and from different schools. Following an informal agreement to participate, and with the University of Southern Queensland Ethics approval, consent was provided by the principals of these teachers. The approval of their school’s governing body was also sought and granted. The participant teachers were required to be located in their classrooms for their interviews as this provided a background imagery consistent with the topics being discussed and as a space in which they felt free to speak candidly. Choosing to be in the classroom also provided an element of trust towards the Researcher on behalf of the teachers. Teachers outside this catchment would be excluded.

3.8 Research Techniques – Paired Depth Interviews

Qualitative research studies generally involve the collection, analysis, and interpretation of data that is not numerical arising from one or more of the following four broad sources: talk, observations, images, and documents (e.g., Houssart & Evens, 2011). Data from talking is usually heard from the voices of one or more participants through individual interviews or focus groups. Several types of interviews can be utilised including structured interviews where all participants are asked the same question in the interview, semi-structured interviews where a set of questions are asked but can be altered depending on the direction the interview takes, unstructured interviews where participants are encouraged to provide as in-depth responses as possible, and non-directive interviews where no structure is provided to the participants and the interviewer follows what the participant is saying (Wilson, 2016).

While individual interviews have become the most common form of data collected in qualitative research studies, ‘paired depth interviews’, where an interviewer interviews two participants at the same time, have become increasingly valued by researchers in the health, wellbeing and helping professions, more specifically relating to counselling therapy, and supervision (Llewelyn, 1988; Ryan & Bardill, 1964; West & Clark, 2004), marriage and family therapy (Ehrenkranz, 1967a, 1967b; Geist & Gerber, 1960; Gullerud & Harlan, 1962; Weisberg, 1964), oncology (Harden, Northouse, & Mood, 006; Morris, 2001; Yosha, et al., 2011), physician-assisted suicide (Back et al., 2002), and child/adolescent issues (Highet, 2003; Houssart & Evens, 2011; Mauthner, 1997; Parrish, Yeatman, Iverson, & Russell, 2012; Zeidler, Walker, Ackett, & Simmons, 2001).

Roulston’s (2010) typology of conceptualisations (Wilson, 2016, p. 1552) for qualitative interviews consisted of the following six conceptions: neo-positivist, romantic, constructionist, postmodern, decolonizing, and transformative. Paired depth interviews appear to be more consistent with the transformative conceptualisation as the researcher and participants, “develop ‘transformed’ or ‘enlightened’ understandings as an outcome of dialogical interaction” (Roulston, 2010, p. 220).

Furthermore, paired depth interviews have the capability to meet Guba and Lincoln’s (1989) five authenticity criteria as outlined by Wilson (2016): catalytic authenticity (i.e., the extent to which the new constructions and understandings of the position of the other participant have changed during the course of the study); educative authenticity (i.e., the extent to which the participants’ appreciation of and gratitude for the constructions of others outside their group are augmented); fairness (i.e., concerning the thoughts, perceptions, feelings, concerns, assertions, concerns, and experiences of each participant being represented in the text); ontological authenticity (i.e., the degree to which the constructions of the participants have developed in a meaningful way as a result of participation in the interview); and tactical authenticity (i.e., the extent to which each participant is emboldened to act on the enhanced understanding that arose as a result of the paired depth interview). In the setting of this study, the participants may work in adjacent classrooms and so paired interviews offered the most optimal use of the participant’s time, with catalytic authenticity and educative authenticity being met. By meeting one or more of these authenticity criteria, paired depth interviews provide a greater advantage for this kind of study as the end result, to develop an online collaborative homework system, would benefit the participants themselves, thereby providing ontological authenticity and tactical authenticity. This is because the resultant technology would be useable by the Participants as the Researcher surmises that they care deeply about their students and want them to succeed in mathematics and life.

As this study aims to identify the features necessary to design an online collaborative homework support system for Australian Year 1 Mathematics, a pair of participants (primary school teachers) may opt for a paired interview if they work together at the same school and have possibly transferred students to each other at the end of the school year. Paired depth interviews in this setting may be advantageous as the participants will already have a pre-established relationship as co-workers (Morris, 2001) and can identify concerns both participants may have in order to gain new awareness and skills (Ehrenkranz, 1967a), especially within the ever-changing technology environment. These relationships between colleagues may be effective because the participants can articulate what they see as missing pieces to the ‘technology’ puzzle that might not have already been realised (Arksey, 1996; Houssart & Evens, 2011; Morris, 2001; Seale et al., 2008), resulting in a more comprehensive dataset as each participant can fill-in where the other participant has memory lapses or gaps in their storytelling (Seymour, Dix, & Eardley, 1995). Further to this, the nature and dynamics of the working relationship can provide insight for the Researcher through the observance of the participants’ non-verbal cues (Arksey, 1996).

The method proposed in this study is to use transformative conceptualisation (Wilson, 2016) individual or paired depth interviews through audio recording. The teacher interviews would build a broad dataset involving different experiences and personal contexts, as they are Curriculum experts. The structure of the interview questions should follow the concepts identified in the literature review (see the Interview Questions in Table 5, p. 76) and the format should allow the participants to explicate their voices around these concepts. It is understood that the data collected from this small sample will be fairly specific and so care should be taken not to make too many generalisations. For practical reasons, most notably the current pandemic and potential lockdowns, parents and students are out of scope for this particular study but would be included in future research.

At the start of the interviews, the Researcher ideally assumes a degree of control, before proffering opportunities for the participants to take over and speak their mind on issues (Creswell, 2003). However, it is understood that the Researcher can bias the interview and this could produce unforeseen errors (Creswell, 2003). These errors can be associated with who answers or errors associated with the answers themselves (Fowler, 2002). To mitigate this, the Researcher will endeavour to lessen any dependence on generalisations or stereotypes.

3.9 Ethical Considerations

Ethics approval was sought from the University of Southern

Queensland before the recruiting of participants commenced. Each Participant was emailed a comprehensive explanation of the research study prior to them providing their consent to participate. Once permission was granted, the researcher worked with each Participant around their schedule for suitable times for interviews. Each Participant was given the option to withdraw via email to the Researcher at any stage without prejudice. Participants were provided the utmost confidentiality with each Participant’s transcripts and recordings stored privately in their own zip encrypted file. Only the Researcher and Participant had access to their zip encryption key. While permission was sought from each primary school principal for each teacher Participant, the actual audio was stored outside of school grounds. Any information about the Participant/interviewees’ identity was kept private and not linked in the study.

3.10 Limitations

Logistical limitations to conducting this study primarily centred around the various restrictions placed on in-person interviews as a result of the COVID-19 pandemic. To overcome this, all interviews were offered through Zoom video if in-person interviews could not take place. From a quantitative perspective, the small sample size was a potential limitation to knowing exactly what can be designed on a larger scale. However, it was expected that this size cohort would still elicit the same common themes and shed light on what is understood (and not understood) in order to identify the features necessary to design a collaborative online homework support system.

Ideally, the teacher participants would have a range of experience in teaching, but it was anticipated that all were current primary school teachers, having had at least five years teaching at primary school and having taught Year 1 within the last three years. These constraints were imposed so that the more recent the participants’ experience of Year 1 mathematics the closer the data would be to reality given the rate of change of technology.

Choosing Year 1 mathematics may also provide limits to answering the research question for all primary schooling, however, the study sought to identify what was understood at the grass-roots level in one subject, which it was hoped would provide a stronger platform for additional research with other year levels and subjects in the primary school setting.

3.11 Outputs of the Data Analysis

The outputs of this data analysis included:

- Development of personas of the participants that informed the framework to develop an online collaborative homework support system and can be used to describe potential users.
- Development of themes to describe the experiences of the participants to identify the features for a collaborative framework.
- A description of the features necessary to develop an online collaborative homework support system.
- Identification of any barriers to developing an online collaborative homework support system.
- Recommendation of methods to overcome any barriers.

4. RESULTS – REFLEXIVE THEMATIC ANALYSIS

Introduction

This chapter provides a step-by-step application of Braun and Clarke's (2021) Reflexive Thematic Analysis (RTA) to this study's data of paired depth interview transcribed data. Section 4.1 outlines RTA phase one: data familiarisation and writing familiarisation notes. Section 4.2 outlines RTA phase two: systemic data coding. Section 4.3 outlines RTA phase three: generating initial themes from coded and collated data. Section 4.4 outlines RTA phase four: naming themes and developing a thematic map. Section 4.5 outlines RTA phase five: refining and defining themes.

Limitations To Finding a Participant Sample

Appendix G details the problems and issues that arose within the backdrop of the COVID19 pandemic to identify potential schools to approach in Queensland. This included identifying potential schools to approach, the process of choosing independent schools, approaching independent schools through emails to principals, and approaching independent school teachers through Facebook. As a result of these limitations this study was limited to participants from Queensland independent schools.

Personas

Table 6 shows the application of personas presented as capitalised in this analysis, as distinguished from general group members presented as lowercase in the literature review:

Table 6

Personas used in this Study's Analysis.

Literature Review (lowercase)		Analysis (uppercase)	
Group Member		Persona	
teacher	This term is used to identify teachers in general throughout the literature review.	**Teacher**	A Teacher is a participant Teacher interviewee in this study's analysis.
parent	This term is used to identify parents in general throughout the literature review.	**Parent**	A Parent is a parent of a Student in a participant Teacher's class in this study's analysis.
student	A term is used to identify students in general throughout the literature review.	**Student**	A Student in a Teacher's class in this study's analysis.
researcher	This term is used to identify the authors of literature used in the literature review and methodology.	**Researcher**	The Researcher is the Principal Investigator of this study's analysis.
participant	This term is used to identify the participants in the studies in the literature review.	**Participant**	The Participants are the Teacher interviewees in this study's analysis.

Coding of Participants

The list of respondent Participant volunteers who met the inclusion limitations as set out in Section 4.9 is tabularised in Table 7 and shows how the participants were coded to their school, location (peri-urban, rural, metro) and the COVID response that was in place at the time of the interview - Phase A (open). Each interview was a paired depth interview.

Table 7

Coding of Participants.

	School	Participant	Participant	Location	COVID
1	01	01	0101	Peri-Urban	Phase A (open)
2	01	02	0102	Peri-Urban	Phase A (open)
3	02	01	0201	Rural	Phase A (open)
4	02	02	0202	Rural	Phase A (open)
5	03	01	0301	Metro	Phase A (open)
6	03	02	0302	Metro	Phase A (open)

Participant Position at School and Personal Backgrounds

All the Participants elected for face-to-face interviews as opposed to online interviews via Zoom. Prior to being granted access to each school, the Researcher provided his Queensland Drivers Licence as identification, Queensland Government Blue Card to allow access to Queensland schools, and a certification the Researcher had received both COVID-19 vaccinations. The Researcher also carried into the school an N-95 mask and hand sanitiser and maintained 1.5 metres distance with all school members. The Researcher attended each school's reception ahead of time and signed into the school's visitor register and confirmed agreement with the school's COVID-19 safety protocols.

- Participant 0101 is female, a mother, has taught early primary (year 1-3) for over twenty years, and has been teaching at School 01 for six years.
- Participant 0102 is female, a mother, has taught early primary (year 1-3) for over twenty years, and has been teaching at School 01 for over fifteen years.
- Participant 0201 is female, has taught early primary (year 1-3) for over ten years, and has been teaching at School 02 for seven years.
- Participant 0202 is female, a mother, has taught early primary (year 1-3) for over ten years, and has been teaching at School 02 for over ten years.

- Participant 0301 is female, a mother, has taught early primary (year 1-3) for over twenty years, and has been teaching at School 03 for over twenty years.
- Participant 0302 is female, has taught early primary (year 1-3) for three years, and has been teaching at School 03 for three years.

Interview Recording and Duration

The Researcher used an iPad to record each interview. The video function was used with a brief visual introduction to the Participants and the Researcher in the classroom. The iPad was then placed camera down so that the remainder of the interview was only recorded by audio. Interview duration for each paired depth interview at each school was as follows:

- School 01 interview duration 49 minutes
- School 02 interview duration 71 minutes
- School 03 interview duration 79 minutes

Tabularised forms have been used extensively in this section to allow the Researcher to use encapsulated forms of data extracts, (and subsequent data familiarisation steps) and their moulding. The Researcher has used this in order to form codes and themes that can be cleanly referred to throughout this thesis.

Review of Braun and Clarke's (2020) Six Phases of Reflexive Thematic Analysis

The Researcher continues from the Methodology section with Braun and Clarke's most recent six phases to conducting Reflexive Thematic Analysis as shown in Table 8.

Table 8

Six Phases of Braun and Clarke's (2020) Reflexive Thematic Analysis.

Six Phases of Braun & Clarke's (2020) Reflexive Thematic Analysis	
1	Data familiarisation and writing familiarisation notes.
2	Systematic data coding.
3	Generating initial themes from coded and collated data.
4	Developing and reviewing themes.
5	Refining, defining and naming themes.
6	Writing the report.

Braun and Clarke make it clear that this six-phase approach, "is not intended to be followed rigidly" (Braun & Clarke, 2020, p. 331), adding that as a researcher's analytic skill develops, these six phases can mix together, and the analytic process can become like a recursive feedback-loop in the development of meaning. As this study is the Researcher's first use of this method the sequence of steps for RTA as presented by Braun and Clarke were ideal for this study.

Phase One

Data familiarisation and writing familiarisation notes:

- familiarity with native (sequential form) paired depth interview transcribed data – see Figure 18.

Figure 18

Example: Native (Sequential Form) Paired Depth Interview Transcription.

Q1. Describe any technologies that you think could include parents to help students engage in mathematics homework - and connects to you and the Curriculum. Participant 1: So, I had a question there with technologies. So, what did you mean? Like in terms of program - computer - like technology as in the hardware or technologies… Researcher: Not hardware. Software. Generally, software. Participant 1: Yeah, so… Researcher: Because generally these - this is what they; only thing at primary that we've been able to tell [unclear] - I've had - you can tell the parents [unclear] this, right? Is that right? Participant 1: Yeah, most people I think would use the iPads. Participant 2: Yep, so I straight away though of things that we've already used like different - like [unclear] ready. Things like our class [unclear] things like that and different - yeah, like already things that they use like Mathletics. Do you mean things like that?

- convert native transcribed paired depth interview data into a column grid. Column grid form is a generic type of data representation rather than a method per se. This type of data representation clearly identifies the voices of the Researcher and Participants (Fah & Aziz, 2006) – see Figure 19.

Figure 19

Example: Researcher/ Participant Column Grid.

Q1 Describe any technologies that you think could include parents to help students engage in mathematics homework - and connects to you and the **Curriculum.**		
Researcher	**Participant 1**	**Participant 2**
	So, I had a question here with technologies. So, what did you mean? Like in terms of a computer program or like technology as in the hardware technologies…	
Not hardware. Software.	Yeah, so…	
Because generally, hardware, like this iPad is the only thing at Primary that we've been able to tell the parents to get.	Yeah, most people I think would use the iPads.	Yep, so I straight away thought of things that we've already used like different websites. Things like ClassDojo and Mathletics.

- combine Researcher/Participant column grid to form a single narrative. Single combined narrative is a descriptive title used to describe the narrative form that combines all members' voices linearly see Figure 20.

Figure 20

Example: Researcher/ Participant Single Combined Narrative.

Q1 Describe any technologies that you think could include parents to help students engage in mathematics homework - and connects to you and the Curriculum. We use Mathletics but that doesn't really connect parents though. It connects us to the Curriculum, and it allows us to help students with their maths, but it doesn't really connect the parents. We used Class Dojo and it had capabilities for us to do little videos and upload messages to parents. For the homework, I would think that they just are able to access tasks and then submit work, but it's more connect for us. It allows children to present information in different ways. Parents are able to see what they put in and we can provide feedback based on what they do but then also making it not too is onerous. So currently we don't use any online homework. It's all old-fashioned pen and paper stuff.

- approval requested and received from participants that Native Paired Depth Interview Transcription and Researcher/ Participant Single Combined Narrative are accurate records and interpretations.

Phase Two

Systematic data coding: objective restatement of the combined Researcher/Participant single narrative to identify and write codes; recursive application of code identification numbers to codes; collating data to develop code groups and code summaries; and recursive application of sentiment notes to codes. Sentiment analysis is a natural language processing technique used to determine whether data is positive, negative, or neutral (Pang, Lee & Vaithyanathan, 2018; Hamborg & Donnay, 2021).

Phase Three

Generating initial themes from coded and collated data: generating a code structure map of the analysis; and generating initial themes from coded and collated data.

Phase Four

Developing and reviewing themes: naming themes; and developing and reviewing themes.

Phase Five

Refining, defining, and naming themes: generating a thematic map of the analysis; and defining themes in relation to the research question.

Phase Six

Writing the report.

Table 9 shows Braun and Clarke’s (2020) phases aligned to accommodate the additional sub-steps of paired depth interviews taken by the Researcher:

Table 9

Comparatively Aligning the Phases of this Study with Braun and Clarke's (2020) Six Phases of Reflexive Thematic Analysis.

Six Phases of Braun & Clarke's (2020) Reflexive Thematic Analysis			**Comparative Phases of Analysis with this study's Paired Depth Interview Data**	
Phase	**Section**		**Sub Section**	
1	**4.1**	Data familiarisation and writing familiarisation notes.	**4.1.1**	Familiarity with native (sequential form) paired depth interview transcribed data.
			4.1.2	Convert Native Transcribed Paired Depth Interview Transcription to Paired Depth Interview Column Grid Form.
			4.1.3	Combine Paired Depth Interview Column Grid Form to form a Single Combined Narrative to be Approved by Participants.
			4.1.4	Approval requested from Participants.
			4.1.5	Objective Restatement of the Combined Researcher/Participant Single Narrative to Identify and Write Codes.
			4.1.6	Recursive Application of Sentiment Notes and Identification Numbers to Codes.
2	**4.2**	Systematic data coding. Collating Data to Develop Code Groups and Code Summary Headings.	**4.2.1**	Code Group 1 & Code Summary Headings.
			4.2.2	Code Group 2 & Code Summary Headings.
			4.2.3	Code Group 3 & Code Summary Headings.
			4.2.4	Code Group 4 & Code Summary Headings.
			4.2.5	Code Group 5 & Code Summary Headings.
3	**4.3**	Generating initial themes from coded and collated data.	**4.3.1**	Theme 1
			4.3.2	Theme 2
			4.3.3	Theme 3
			4.3.4	Theme 4
			4.3.5	Theme 5

Six Phases of Braun & Clarke's (2020) Reflexive Thematic Analysis			Comparative Phases of Analysis with this study's Paired Depth Interview Data	
Phase	**Section**		**Sub Section**	
4	**4.4**	Naming themes and developing thematic maps.	**4.4.1**	Theme Name 1 & Thematic Map.
			4.4.2	Theme Name 2 & Thematic Map.
			4.4.3	Theme Name 3 & Thematic Map.
			4.4.4	Theme Name 4 & Thematic Map.
			4.4.5	Theme Name 5 & Thematic Map.
5	**4.5**	Refining and defining Themes.	**4.5.1**	Associating Themes and their Respective Codes in Appendices.
6	**5**	Writing the report.	**5**	Defining themes in relation to the research question.

4.1 Phase One: Data Familiarisation and Writing Familiarisation Notes

As per assumption four of Braun and Clarke's (2021) Core Assumptions list, the Researcher was the only coder/analyst in this Reflexive Thematic Analysis. The Researcher became familiar with the Participant interviews by being present to perform the interview and after by a re-listening of each recording prior to it being sent to the transcription service. By reading the transcriptions along with the recording, the Researcher was able to check for accuracy, while building familiarity of the transcribed interviews.

4.1.1 Familiarity with Native (Sequential Form) Paired Depth Interview Transcribed Data.

The Researcher recorded interviews were used to transcribe the data, as it was spoken, by an independent transcription service. Table 10 shows an example of a native transcribed paired depth interview transcription extract from within the paired depth interview of Question 2 with Participant 0301 and Participant 0302 from School 03.

Table 10

Native Transcribed Paired Depth Interview Transcription Extract Q.2 with Participant 0301 & 0302 from School 03.

Q2. Describe how any of these technologies could engage students in mathematics homework - with you, their parent, and the Curriculum.
Researcher: *"What about learning objectives? Would they understand what that means?"* **Participant 0301:** *"We like to* ***integrate everything: mathematics, literacy, and reading. You can't teach mathematics without literacy****. Well we have in the beginning of the year, we actually didn't have it this year for some reason but usually in the beginning of the year we have what we call a numeracy and literacy…"* **Participant 0302:** *"Parent information evening…"* **Participant 0301:** *"…information evening. All the Parents come and we explain how we do reading and how we do spelling and how we do maths and give them some tips. It's usually very well received. They come in their droves and listen to us present."* **Participant 0302:** *"We can say how you can help at home. Do X, Y, Z."* **Participant 0301:** *"Because we also - sorry."* **Participant 0302:** *"There's also on our school portal website, there's now a Parent hub where they can go for - I think there's articles up there written for Parents. There's access to different resources on* ***how to help your child****. There's links to…"* **Participant 0301:** *"Yep, like specific things, not just airy-fairy waffle."* **Participant 0302:** *"Yeah."* **Participant 0301:** *"Yep. Yeah, we - oh what was I going to say? Oh, we do sometimes have Parents who think they are helping, a little bit like your story, but they - I don't know, because they don't know what the kids are expected to be doing, they will teach them times tables. It's great to know your times tables like a parrot but if you can't apply it to a math's problem, then you're actually doing more harm, I think."*

4.1.2 Convert Native Transcribed Paired Depth Interview Transcription to Paired Depth Interview Column Grid Form

With the transcribed paired depth interview, the Researcher copied the words of each Participant verbatim as they appeared in the transcription into a spreadsheet in grid form so that the dialogue could be viewed horizontally from left to right in discreet blocks. With this method the Researcher was able to separate out with bullet points the individual sections of the dialogue of each Participant within each block. Table 11 shows an example of a conversion of the native transcribed paired depth interview transcription to paired depth interview column grid form from within the paired depth interview of Question 2 with Participant 0301 and Participant 0302 from School 03.

Table 11

Conversion of the Native Transcribed Paired Depth Interview Transcription to Paired Depth Interview Column Grid Form

Q.2 with Participant 0301 & 0302 from School 03.

<table>
<tr><th colspan="2">Q2. Describe how any of these technologies could engage students in mathematics homework - with you, their parent, and the Curriculum.</th></tr>
<tr><td colspan="2">Researcher</td></tr>
<tr><td colspan="2">“What about learning objectives? Would they understand what that means?”</td></tr>
<tr><td>Participant 0301</td><td>Participant 0302</td></tr>
<tr><td>● “We like to <u>integrate everything: mathematics, literacy, and reading. You can’t teach mathematics without literacy</u>. “</td><td></td></tr>
<tr><td>● “Well we have in the beginning of the year,
● we actually didn’t have it this year for some reason
● but usually
● in the beginning of the year
● we have what we call a numeracy and literacy…”</td><td></td></tr>
<tr><td>● “…information evening.
● All the parents come and
● we explain how we do reading and
● how we do spelling and
● how we do maths and
● give them some tips.
● It’s usually very well received.
● They come in their droves
● and listen to us present.”</td><td>● “We can say how you can help at home.
● ‘…Do X, Y, Z….’”</td></tr>
</table>

Q2. Describe how any of these technologies could engage students in mathematics homework - with you, their parent, and the Curriculum.	
Researcher	
"What about learning objectives? Would they understand what that means?"	
Participant 0301	**Participant 0302**
● *"Because we also - sorry…"*	● *"There's also on our school portal website,* ● *there's now a parent hub where they can go for* ● *I think there's articles up there written for Parents.* ● *There's access to different resources* ● *on **<u>how to help your child</u>**.* ● *There's links to…"*
● *"Yep, like specific things, not just airy-fairy waffle."*	● *"Yeah."*
● *"Yep. Yeah, we - oh what was I going to say? Oh,* ● *we do sometimes have Parents who think they are helping,* ● *a little bit like your story, but they - I don't know,* ● *because they don't know what the kids are expected to be doing,* ● *they will teach them times tables* ● *It's great to know your times tables like a parrot* ● *but if you can't apply it to a math's problem,* ● *then you're actually doing more harm, I think."*	

4.1.3 Combine Paired Depth Interview Column Grid Form to form a Single Combined Narrative to be Approved by Participants

Following completion of the transcription, the Researcher created a single objectively restated narrative from the grid by combining the Paired Depth Interview in column grid form to form a single narrative. Using this method, the Researcher identified and removed dialogue that was repeated, mis-pronounced, incorrectly spelled, mis-transcribed by the transcriber, or was superfluous to the "intended meaning" of the Participant, as is good practice in Thematic Analysis. It is noted that the participant Teachers (all female) often referred to the Students in their class with possessive pronouns, such as “our kids” or “my kids”, which demonstrated the care and attention these Teachers had for their class. Other edits included making consistent the use of pronouns, titles, or possessives, that could be made with words with ambiguously meanings, for example the transcription of Participant 0302 “how to help your child” (bold, italic, and underline in Table 12) was edited to be “how to help their child” (bold, italic, and underline in Table 11 and subsequently maintained in Tables 12, 13 and 15). Table 12 shows an example of a single narrative from combined paired depth interview column grid form from within the paired depth interview of Question 2 with Participant 0301 and Participant 0302 from School 03.

Table 12

Single Narrative from Combined Paired Depth Interview Column Grid Form Q.2 with Participant 0301 & 0302 from School 03.

Q2. Describe how any of these technologies could engage students in mathematics homework - with you, their Parent, and the Curriculum.
*“We like to **integrate everything: mathematics, literacy, and reading. You can’t teach mathematics without literacy** (**0301**). In the beginning of the year we have what we call a ‘numeracy and literacy Parent information evening’ (**0301**). All the Parents come, and we explain how we teach reading, how we teach spelling, and how we teach maths, and give them some tips. It’s usually very well received. They come in their droves and listen to us present. (**0301**) We can say how they can help at home. (**0302**) There’s also, on our school portal website, a Parent hub where they can go for articles written for Parents. There’s access to different resources on **how to help their child**. (**0302**) We do sometimes have Parents who think they are helping, but they don’t, because they don’t know what the kids are ‘expected’ to be doing. For example, they might teach them times tables (at home). It’s great to know your times tables like a ‘parrot’, but, if you can’t apply it to a math’s problem, then you’re actually doing more harm.” (**0301**)*

4.1.4 Approval Requested from Participants

The Researcher took care to still be able to access each Participant’s words through their respective Participant code within this combined Paired Depth Interview (bold and in brackets in Table12 and Table 13) to be able to assure Participants, Co-Investigators, and Assessors of the true origin of the words if demonstration is required. This single narrative was sent to the Participants for their option to check and provide edits or else clarification, along with the original raw transcriptions.

4.1.5 Objective Restatement of the Combined Researcher/Participant Single Narrative to Identify and Write Codes

Following approval from Participants, the Researcher commenced the coding process. Braun and Clarke put researcher subjectivity front and centre in Reflexive Thematic Analysis (Braun & Clarke, 2021, p.7) and refer to Trainor and Bundon (2020) to encourage a “deep” process of reflexive cross-examination of researcher assumptions and training, as opposed to a simple list of “identity or experience categories” when reporting research. They inspire the Researcher to embark on coding as a process that is fuelled by subjectivity:

> Coding, for example, is a process not of simple identification, but of interpretation— and researcher subjectivity fuels this process. Good coding (coding that is more complex and nuanced) is often the result of a deep and prolonged engagement with the data; codes can and should evolve in an organic way over the coding process, as insight shifts and changes. Individual codes can expand and contract in scope, be collapsed together with other codes, split into two or more codes, and coding labels can be refined. The point of this organic coding process is precisely to capture the researcher’s developing and deepening interpretation of their data. Even at the endpoint of coding, things are still provisional.
> (Braun and Clarke, 2021, p.7)

To facilitate this method, the Researcher first objectively restated the Combined Researcher/Participant single narrative to identify and write codes, then recursively applied sentiment notes along with code identification numbers to coded data. This collated data was then used to develop Code Groups and Code Summaries.

The participant approved combined single narrative was inserted into the NVIVO software program and using the *Annotations* function in that software the Researcher identified blocks of dialogue to attach Coding. Using this method, the Researcher was able to interpret instances that contained the meaning that the Researcher deemed to be the truth of what was being said by the Participant to objectively restate what was said to develop a code. Table 13 shows an example of how codes were identified based on the combined single narrative from within the paired depth interview of Question 2 with Participant 0301 and Participant 0302 from School 03.

Table 13

Identifying Codes in the Combined Single Narrative

Q.2 with Participant 0301 & 0302 from School 03.

Q2. Describe how any of these technologies could engage students in mathematics homework - with you, their Parent, and the Curriculum.	
Combined Single Narrative	**Code**
"We like to ***integrate everything: mathematics, literacy, and reading. You can't teach mathematics without literac****y." (***0301***)*	Mathematics has to be taught alongside literacy.
*"In the beginning of the year we have what we call a 'numeracy and literacy Parent information evening'" (****0301****) "All the Parents come, and we explain how we teach reading, how we teach spelling, and how we teach maths, and give them some tips. It's usually very well received. They come in their droves and listen to us present." (***0301***) "We can say how they can help at home." (****0302****) "There's also, on our school portal website, a Parent hub where they can go for articles written for Parents. There's access to different resources on* ***how to help their child****." (***0302***)*	Teachers often offer open nights at the year's commencement to address all parents together as to how they will conduct their teaching for the year.
*"We do sometimes have Parents who think they are helping, but they don't, because they don't know what the kids are 'expected' to be doing. For example, they might teach them times tables (at home). It's great to know your times tables like a 'parrot', but, if you can't apply it to a math's problem, then you're actually doing more harm." (***0301***)*	Teachers are frustrated and see it as harmful when Parents try to teach their children things other than what the child is expected to be doing and without any application to a maths problem, as it is often based on how the Parent learned the concept.

4.1.6 Recursive Application of Sentiment Icon Notes, Code Identification Numbers, and Code Summary Headings

The following processes of applying sentiment codes and code identification numbers was an iterative and recursive process with the Code Summary Headings (Braun & Clarke, 2020):

- Applying sentiment icons
- Applying code identification numbers

Table 14 shows Core Assumptions five and six of Braun and Clarke's Ten Core Assumptions of Reflexive Thematic Analysis (from Table 3, p. 60) that helped the Researcher maintain objective clarity (Braun & Clarke, 2021, p. 6):

Table 14

Braun & Clarke's (2021) Core Assumptions 5 & 6 of Reflexive Thematic Analysis.

Braun & Clarke's (2021) Core Assumptions of Reflexive Thematic Analysis	
5	Themes are analytic outputs, not inputs, and are developed after coding and from codes.
6	Themes are patterns of meaning anchored by a shared idea or concept (central organizing concept) not summaries of meaning related to a topic.

Sentiment Icons.

Sentiment icons offer a way for the Researcher to quickly identify the emotion or feeling of the words used by the Participant (Dumbleton, 2020):

- (✓) Identifying a need in a potential online collaborative homework solution
- (+) Identifying a positive attitude to the dialogue
- (-) Identifying a negative attitude to the dialogue
- (±) Identifying an indifferent attitude to the dialogue

Code Identification Numbers.

Codes identification numbers were developed and constructed recursively with code summary headings and an example of this is Code 3.5.7 (see Appendix F, Table F3.5):

3.5.7 Mathematics has to be taught alongside Literacy.

The construction of this code was from a common concept that every participant spoke to. One such example is the derivation from Participant 0301 shown in bold, italic, and underlined in Table 15:

We like to integrate everything: mathematics, literacy, and reading.

You can't teach mathematics without literacy. (0301)

Code numbers were then attached to codes and grouping was enabled – see Table 15.

Table 15

Applying Code Identification Numbers and Sentiment Codes

Q.2 with Participant 0301 & 0302 from School 03.

Q2. Describe how any of these technologies could engage students in mathematics homework - with you, their Parent, and the Curriculum.	
Combined Single Narrative	**Code**
"We like to ***integrate everything: mathematics, literacy, and reading. You can't teach mathematics without literacy****."*	Mathematics has to be taught alongside literacy. **3.5.7. (±)**
"In the beginning of the year we have what we call a 'numeracy and literacy Parent information evening'. All the Parents come, and we explain how we teach reading, how we teach spelling, and how we teach maths, and give them some tips. It's usually very well received. They come in their droves and listen to us present. We can say how they can help at home. There's also, on our school portal website, a Parent hub where they can go for articles written for Parents. There's access to different resources on ***how to help their child****."*	Teachers often offer open-nights at the year's commencement to address all Parents together as to how they will conduct their teaching for the year. **5.1.7. (±)**
"We do sometimes have Parents who think they are helping, but they don't, because they don't know what the kids are 'expected' to be doing. For example, they might teach them times tables (at home). It's great to know your times tables like a 'parrot', but, if you can't apply it to a math's problem, then you're actually doing more harm…"	Teachers are frustrated and see it as harmful when Parents try to teach their children things other than what the child is expected to be doing and without any application to a maths problem, as it is often based on how the Parent learned the concept. **5.1.4. (-)**

4.2 Phase Two: Systemic Data Coding

Following this application of code numbers to dialogue using the NVIVO software Tables 16, 17, 18, 19, and 20 show the code summary headings and code groups that each code was eventually attached under.

4.2.1 Code Group 1: The Curriculum

Code Group 1 was named *The Curriculum* because this represented the participant's comments that related specifically to the Australian Mathematics Curriculum. Table 16 shows the collated Code Summaries under Code Group 1.

Table 16

Collated Code Summary Headings for Code Group 1.

Code Group 1	Code Summary Heading
The Curriculum	1.1 Teacher Perspective of the Curriculum 1.2 Learning Objectives 1.3 Strands - Proficiency Level Descriptions 1.4 Strands - Content Descriptions 1.5 Achievement Standards 1.6 Work Sample Portfolio – Content

The largest Code Summary, *1.1 Teacher Perspective of the Curriculum*, contains codes that are largely supportive of the Curriculum but note it is difficult to navigate especially if a teacher wanted to print out part of it. For example, see code *1.1.9 Teachers are trained to be able to navigate the Curriculum but can't easily print it for offline use or for parents because the links to the Elaborations click backwards.* (see also Appendix F, Table F1).

4.2.2 Code Group 2: The Classroom

Code Group 2 was named *The Classroom* because these codes represented those activities that teachers apply from their university training and experience such as formative and summative assessment, classroom ability groups, and privacy. Table 17 shows the collated Code Summaries under Code Group 2.

Table 17

Collated Code Summary Headings for Code Group 2.

Code Group 2	Code Summary Heading
The Classroom	2.1 Classroom Teaching 2.2 Collaboration in the Classroom 2.3 Formative Assessment 2.4 Summative Assessment 2.5 Classroom Ability Groups 2.6 Classroom Apps 2.7 Privacy 2.8 Home-Class teaching During COVID Lockdowns

As an example, in Code Summary *2.2 Collaboration in the Classroom* some Teachers promoted classroom peer collaboration (see 2.2.1 in Appendix F, Table F2) but identified the downside of Students comparing themselves when they collaborate (see 2.2.2 in Appendix F, Table F2). Also of note in Code Summary 2.6 *Classroom Apps* is a list in tabularised form the usage each participant had for classroom apps. Further dialogue took place in Code Summary 2.8 *Home-Class teaching During COVID Lockdowns* around teaching during the COVID-19 lockdowns summarising that “Teachers were overworked preparing and managing Home-Class during lockdowns and were generally negative about the experience” (see 2.8 in Appendix F, Table F2).

4.2.3 Code Group 3: Teachers

Code Group 3 was named *Teachers* because it contained codes related to a Participant/Teacher’s knowledge of the Students in their class and how some of the educational methods might be applied to a homework situation, such as learning objectives, evidence, extension and homework apps. Table 18 shows the collated Code Summaries under Code Group 3.

Table 18

Collated Code Summary Headings for Code Group 3.

Code Group 3	Code Summary Heading
Teachers	3.1 Ability Groups 3.2 Learning Objectives 3.3 Evidence 3.4 Extension 3.5 Reading-Literacy 3.6 Written Homework 3.7 Socioeconomic-Cultural 3.8 Homework Apps

Code Summary 3.1 *Ability Groups* extensively notes that with the concept of Ability Groups that "Teachers would prefer ability grouping to work undetectable by Students in the background" (see 3.1 in Appendix F, Table F3). 3.2 *Learning Objectives*, 3.3 *Evidence*, and 3.4 *Extension* were areas that contained various zones of overlap, but the Researcher saw the importance of distinguishing these as they pertain directly to the construction of features for a collaborative online homework support system (see 3.2, 3.3, and 3.4 in Appendix F, Table F3). A tabularised list of the homework apps the Teachers used by each participant is shown in 3.8 in Appendix F, Table F3.

4.2.4 Code Group 4: Parent-Child Collaboration

Code Group 4 was named *Parent-Child Collaboration* as these Code Summaries related to how the Teachers saw this interaction. Table 19 shows the collated Code Summaries under Code Group 4.

Table 19

Collated Code Summary Headings for Code Group 4.

Code Group 4	**Code Summary Heading**
Parent-Child Collaboration	4.1 Collaboration 4.2 Feedback 4.3 Hands-On and Manipulatives 4.4 Homework in Context 4.5 Incidental Maths 4.6 Video-Photo

Of note is that of the six participants, four had children over the age of five, which helped provide a diversity of having experienced children at primary school and not having any. The most pertinent Code Groups to be mentioned are 4.2 *Feedback* and 4.3 *Hands-On and Manipulatives* (see 4.2 and 4.3 in Appendix F, Table F3) as the Researcher identified high positive attitude sentiments from the dialogue (+), as well as offerings of ideas needed in a potential online collaborative homework solution (✓) across the whole participant group. What surprised the Researcher most was the keenness the Participants had to engage with offering ideas that could produce a workable online collaborative homework solution. With respect to 4.2 *Feedback,* Teachers sought to provide specific individualised feedback formatively to Parents and Students and that a homework system should allow Parents to provide feedback (4.2.1) and make it easy to provide feedback to a Parent and Student if they are doing well and offer them more challenging extension tasks (4.2.4). The confidence Teachers had with 4.3 *Hands-On and Manipulatives* appeared to be a challenge for Teachers to connect with consistency between the classroom and the home as this recursively leads back to the issue of 3.3 *Evidence*. Of the tangible issues, this one appears to be the biggest barrier to developing a system that could connect between home and class.

4.2.5 Code Group 5: Teacher-Parent Collaboration

Code Group 5 was named *Teacher-Parent Collaboration* as these Code Summaries were generally connected to *Parental Collaboration* (5.2) and the most mitigating factors: *Teachers Teaching Parents* (5.1) and *Time* (5.3). Table 20 shows the collated Code Summaries under Code Group 5.

Table 20

Collated Code Summary Headings for Code Group 5.

Code Group 5	Code Summary Heading
Teacher-Parent Collaboration	**5.1 Teachers Teaching Parents*** 5.2 Parental Collaboration 5.3 Time

All Teachers discussed the issue of collaboration, but the Researcher identified higher negative attitude sentiments from the dialogue (-) than positive (+). For example, while the Teachers discussed their mostly negative sentiment of having to teach Parents (5.2.22) as a waste of time (5.1 *Teachers Teaching Parents*), they acknowledged that both Teachers and Parents would not want to waste time on homework if they did not believe it works (5.3 *Time*). The frustration (5.2.26) and dismay (5.2.25) was clear from the Teachers, especially when Parents would demand homework be delivered (5.2.28) and then some Parents not even bothering to help their child (5.2.29). However, the issue of 'Trust' that the Teacher could not know whether it was the Student or the Parent doing the work (5.2.19, 5.2.23, 5.2.30) was what caused the most pain with Teachers. This again links recursively back to the issue of *Time*.

4.3 Phase Three: Generating Initial Themes from Coded and Collated Data

Braun and Clarke make clear that themes, like codes "are understood as the output of the analysis" and that themes established from codes are constructed at the juncture of "the data, the researcher's subjectivity, theoretical and conceptual understanding, and training and experience" (Braun and Clarke, 2021, p. 7). After careful deliberation at this junction, the Researcher developed the following initial five themes. The following exerts use illustrative quotes from participants direct from the transcriptions under each theme and under their associate Code and Code Summaries.

Sentiment icons are applied in brackets (see Section 4.1.6 above):

(✓) identifying a need in a potential online collaborative homework solution

(+) identifying a positive attitude to the dialogue

(-) identifying a negative attitude to the dialogue

(±) identifying an indifferent attitude to the dialogue

4.3.1 Theme 1 – Code Group 1: The Curriculum

Theme 1 reveals an association between the Teachers appreciation of the Curriculum and their concern that it is too generalised in some areas and too specific in others, and stress that without their training and experience, Parents are unable to fully understand and interpret it. Some of the Teachers were unsure whether it is a good thing for Parents to have access to the Curriculum (1.1.8) because even with years of training and experience to be able to interpret and deliver the Curriculum (1.1) it is too full (1.6.2) and has complicated Achievement Standards that could be written simpler with dot points (1.5.4). Table 21 shows the Theme under Code Group 1: The Curriculum.

Table 21

Theme for Code Group 1: The Curriculum.

Theme 1	Code Group 1	Code Summary Heading
Teachers appreciate the Curriculum but grapple with it being either too generalised in some areas and too specific in others, and stress that without their training and experience Parents are unable to fully understand and interpret it.	The Curriculum	1.1 Teacher Perspective of the Curriculum 1.2 Learning Objectives 1.3 Strands - Proficiency Level Descriptions 1.4 Strands - Content Descriptions 1.5 Achievement Standards 1.6 Work Sample Portfolio – Content

Code Summary 1.1 - Teacher Perspective of the Curriculum

This code summary identifies a set of five positive sentiments of the Curriculum where it is clear, explicit in steps, easy to follow, in increments that make it easy to differentiate so a teacher can create a unit plan around Year 2 and differentiate it down to Year 1, easier to navigate than the English part, and has ‘Indicators’ that define what a student needs to do. This code summary also identifies five negative sentiments of the Curriculum where it is not something teachers would invite parents to look at, requires effort for parents to navigate, Teachers are unsure whether it is a good thing for parents to have access to the Curriculum, Teachers are trained to be able to navigate the Curriculum but can’t easily print it for offline use or for parents because the links to the Elaborations click backwards, and Teachers are unsure whether a parent would understand what everything means on the Curriculum especially Elaborations. The transcribed exerts from Codes 1.1.8 and 1.1.9 demonstrate part of this.

Code 1.1.8 - Teachers were unsure whether it is a good thing for Parents to have access to the Curriculum. (-)

> “Well, I don’t know, as a parent, I never went - I don’t know - I never looked up the Australian Curriculum because I don’t think it was as accessible as it is now, but do you know if parents have access? Can they see exactly what we see? I don’t actually know. I’ve never even thought about that question. Do they actually know where to look?”
> (Participant 0301)
>
> “The parents are not responsible for looking into the curriculum or finding out what they should be learning.”
> (Participant 0101)

Code 1.1.9 - Teachers are trained to be able to navigate the Curriculum but can’t easily print it for offline use or for parents because the links to the Elaborations click backwards. (-)

> “I’m going to say here from an old school person, when I saw it the first time, I thought oh, I want to see it in paper. I want to page through it. So, I made it into a document for myself and of course I realised that the links don’t work, and for the elaborations you had to go back. Anyway, it wasn’t something that you could actually easily put on paper, but I know my way around it now because I know where to look but I don’t know if

parents would."

(Participant 0301)

"It is true that yeah, the Australian curriculum website, you do have to probably navigate a bit more."

(Participant 0201)

Code Summary 1.5 – Achievement Standards

This code summary identifies three negative sentiments for Achievement Standards where specific feedback to a parent of whatever their child is learning about would be better than the Achievement Standard levels: 'above satisfactory', 'satisfactory', 'below satisfactory', teachers need a bank of more specific feedback comments to choose from when marking homework instead of manually writing notes, and the Achievement Standards in the Curriculum is a lot of writing when it would be clearer and concise with dot points. The transcribed exerts from Codes 1.5.4 demonstrates part of this.

Code 1.5.4 - The Achievement Standards in the Curriculum is a lot of writing when it would be clearer and concise with dot points. (-)

"It is a lot of writing for an achievement standard."

(Participant 0302)

"Yeah, I think it would be easy if it was just simple dot points."

(Participant 0301)

Code Summary 1.6 – Work Sample Portfolio - Content

This code summary identifies two negative sentiments for work sample portfolio where Teachers at independent schools don't use the content provided on the Australian Curriculum website and Teachers find the amount of content required to be covered for Grade 1 in the Curriculum is heaps and does not account for the full range of learning needs. The transcribed exert from Codes 1.6.2 demonstrates part of this.

Code 1.6.2 - Teachers find the amount of content required to be covered for Grade 1 in the Curriculum is extensive and does not account for the full range of learning needs, for example a student might not understand 'data and graphs' from one Strand but is now understanding 'shapes' from another Strand. (-)

> "What I've found is the amount of content that they expect Grade 1 to cover is heaps and we are going through one week we're talking about data and graphs. So that's four one-hour maths lessons we're doing data and graphs and then oh, next week it's shapes. Then four one-hour lessons about shapes and then it's by the end of that four-hour period that it's just expected this child gets it."
> (Participant 0302)

4.3.2 Theme 2 – Code Group 2: Learning Starts in the Classroom

Theme 2 collated many positive attitude sentiments as Teachers see their classroom as the hub from where they can drive learning by mixing Students with different abilities and formatively assessing them. They see the classroom as a place where meetings with Parents can take place incidentally at drop-off or pick-up (2.1.2) and negotiate (2.1.1) and apply formative feedback to Students (2.2.2) because they can see the evidence of a Student's performance as it happens (2.3.3) and discover any mathematical misconceptions and rectify them early (2.3.4). They also have the advantage within the classroom of being able to mix the Students up 'on-the-fly' to promote collaboration and peer mentoring (2.2.1). However, the concept of privacy was met with concern as it appeared all the Teachers worked within school rules (2.7.1) and methods (2.7.3) that needed greater strengthening and protection to cope with greater digital infiltration (2.7.5) and the potential for data leakage (2.7.6) or outside misuse (2.7.7). Table 22 shows the Theme under Code Group 2: Learning Starts in the Classroom.

Table 22

Theme for Code Group 2: Learning Starts in the Classroom.

Theme 2	Code Group 2	Code Summary Heading
Teachers see their classroom as the hub from where they can drive learning by mixing students with different abilities and formatively assessing them.	Learning Starts in the Classroom	2.1 Classroom Teaching 2.2 Collaboration in the Classroom 2.3 Formative Assessment 2.4 Summative Assessment 2.5 Classroom Ability Groups 2.6 Classroom Apps 2.7 Privacy 2.8 Home-Class teaching During COVID Lockdowns

Code Summary 2.1 - Classroom Teaching

This code summary identifies three positive sentiments for classroom teaching where Teachers can negotiate in the classroom with students who are having difficulty, Teachers can collaborate with parents in the classroom after school to teach parents concepts, and Year 1 students need hands-on learning in the classroom. The transcribed exerts in Codes 2.1.1 and 2.1.2 demonstrate part of this.

Code 2.1.1 - Teachers can negotiate in the classroom with students who are having difficulty. (+)

> "In terms of collaboration between myself and the student, if a child was having difficulty with something, we could negotiate – if we were to go down the avenue of having technology as part of homework, we could negotiate specific things to help a child achieve a specific goal, rather than it being a general homework. It could be more targeted if we're looking down the road of collaboration between myself and the student for a mathematics homework."
>
> (Participant 0102)

Code 2.1.2 - Teachers can collaborate with parents in the classroom after school to teach parents concepts. (+)

> “So, I give the students feedback on their maths once a week. The parent may not understand the terminology of skip counting, so that’s when the parent – I often have the parents come and read that feedback and I’ve had one parent in particular with a Year 1 boy and she said, well, what is skip counting? So, that’s how we would collaborate during our time in the classroom… or they come in and they’re looking at the child’s book and then they often clarify the terminology with us and then we can explain it. They are often surprised by how simple it is because when they went to school it was called something else. So, it’s just to make that connection between this context and that context, the past and the future.” (Participant 0102)

Code Summary 2.2 - Collaboration in the Classroom

This code summary identifies one positive sentiment for collaboration in the classroom where Teachers promote collaboration and peer mentoring. It also identifies three negative sentiments where some teachers don't allow students to compete and compare themselves against their peers through measured learning, inter-parent or inter-student knowledge of a student's performance position in their class is not valuable, and competition that identifies students in the classroom can work against the ones who score the lowest. The transcribed exerts from Codes 2.2.1 and 2.2.2 demonstrate part of this.

Code 2.2.1 - Teachers promote collaboration and peer mentoring in the classroom by grouping students together with differing fluency levels, especially when some students need more than one person to show them how to work a problem. (+)

> “Sometimes it’s a matter of voice, which is why you promote collaboration and peer mentoring. If a child is so fluent at something, you would say, can you go over there and show that person how to do it? I’ve shown them, they’ve seen a video, but sometimes we need more than one person to tell them how to

do it."

(Participant 0102)

Code 2.2.2 - Some teachers don't allow students to compete and compare themselves against their peers through measured learning.(-)

"I would prefer to look at it that the child understand that their learning is differentiated, that we all come in at a certain level and our responsibility is to grow from wherever that is. So, it's obvious in a classroom who is at whatever level, but it's not as a pitching one child against another, it's more of a healthy competition where I'm here but I want to be here, and I'm here but I'd like to get here, but I know that if I'm going to get from there to there, I've got to work really hard. So, from that aspect, it's great, but not to say, well, you're in this group because you haven't achieved. That's not how it works. Schooling is meant to feel like steps. I'm on this step but I need to get to this step, how do I do that? It's our job to teach them that healthy way of saying, I'm meant to be a responsible learner; to do that I need goals. My job is to help them know what the next goal is. The children know what the expectations are and its growth. You can't stay at the level you're at because you'll never flourish."

(Participant 0101)

Code Summary 2.3 - Formative Assessment

This code summary identifies four positive sentiments for formative assessment where extension ability groups are encouraged for intelligent students so they can formatively identify with their teacher aid the strategy or strategies they could apply to a problem, in the classroom teachers see the Evidence of a student's performance directly, teachers are guaranteed diagnostics to be formative in the classroom and authentically the student's, and teachers can discover mathematical misconceptions in the classroom in a formative way and rectify them early. The transcribed exerts from Codes 2.3.3 and 2.3.4 demonstrate part of this.

Code 2.3.3 - Teachers are guaranteed diagnostics to be formative in the classroom and authentically the student's. (+)

> "But you wouldn't rely on homework for that because parents have too much input into homework, and you don't know how much it's been led. So, if we were going to do any kind of diagnostics, it wouldn't happen between us and home, it would always happen in the classroom because that's when you can be guaranteed that what you're getting is authentic and it's from the child."
>
> (Participant 0101)

Code 2.3.4 - Teachers can discover mathematical misconceptions in the classroom in a formative way and rectify them early. (+)

> "Mathematics is tricky because it's not just about the answer at the end, it's very much about the process, so we actually want to see the child working every day in the classroom because without seeing how they get an answer, you can't discover misconceptions and you pick up misconceptions so early if you're watching everything that they're doing and how they go about it. So, you rectify those before they become habits."
>
> (Participant 0101)

Code Summary 2.7 - Privacy

This code summary identifies three negative sentiments for privacy where teachers have to act precautionary and within school/parent guidelines to maintain privacy of photos of students and their identification, teachers have to take precautions to maintain privacy so as not to publicly allow a student's identify be linked to their performance, and privacy is a concern if videos of our children are shared with parents from another school. The transcribed exerts from Codes 2.7.1, 2.7.3, 2.7.5, 2.7.6, and 2.7.7 demonstrate part of this.

Code 2.7.1 - Privacy is like an understanding with our parents. (±)

> "So, there's privacy within the class."
>
> (Participant 0102)
>
> "It's like an understanding with our parents, isn't it? I don't think any of them would forward the links or whatever. No, they can

view only. Can they communicate to another parent? We BCC in the e-mail, so… not to each other. But they obviously speak to each other and a lot of them share – they're friends anyway."

(Participant 0101)

Code 2.7.3 - A photo sent by a parent direct to the teacher of the work a student has done on an activity at home is private. (±)

"The other thing that we did in terms of getting things done at home and at school was that they were taking photos as evidence of work that they were doing and then they were submitting it and then I was able to give them feedback. The most common way that we communicate here at the school is through e-mails. I send it to myself and BCC [Blind Carbon Copy] it to all the parents, so I have it in my e-mail, they have it in their e-mail. If I need to re-send the link, I sent it to each parent individually so they're not able to see anyone else's e-mails."

(Participant 0102)

Code 2.7.5 - Teachers have to take precautions and within school/parent guidelines to maintain privacy of photos of students and their identification. (-)

"If we have photos on our class website, we know – because it's through the school – so parents might have different parameters for social media, so we abide by those. So, if the child's work can go up but perhaps without a name, that's okay, so we just know all of those things and we're just careful that we abide by the parent requests, but most parents are fine with it."

(Participant 0101)

Code 2.7.6 - Teachers have to take precautions to maintain privacy so as not to publicly allow a student's identify be linked to their performance. (-)

"No, I don't think they need to see where they are against others. Not at all. Nor parents to see other student's performance. For a teacher, I think it would be valuable. I don't

think parents or students need to know."
(Participant 0202)

Code 2.7.7 - Privacy is a concern if videos of our children are shared with parents from another school. **(-)**

"Well, that's got me worried now because all of our online learning, because we do a lot of phonics and sounding out words and things like that. We had to film ourselves teaching the lesson and then posting that on Google Classroom so that the parents could show it to the children but never have I thought what happens if those parents take that video we've shared with them and go and share it with parents from another school?"
(Participant 0302)

4.3.3 Theme 3 – Code Group 3: Teachers

Theme 3 reveals that a Teacher's 'knowledge' of a student allows them to dynamically connect a student's individual goals within the Curriculum's learning objectives to differentially assign them to ability groups and formatively record and feedback to them and their Parents. While this revelation looked at the Teacher and how they worked with their students in the classroom, they offered a number of ideas (✓) as to what classroom methods would need to be replicated for the success of a potential online collaborative homework solution. Suggestions such as providing Parents with learning objectives linked to their child's strengths to form a report for the Teacher to comment on (3.2.2) and measuring a Student's understanding, fluency and problem solving against those learning objectives (3.2.3). Furthermore, a homework program should retain digital evidence of a task set by a Teacher based on those learning objectives that shows a Student's progress/success to dynamically accrue that data to their report card (3.3.4). This is recursively linked to how Teachers regard Student videos and photos as genuine evidence (3.3.1). With regard to applying extension to an online collaborative homework system, it should allow Teachers the option to provide a Student an additional activity (3.4.1) and direct enquiring Students to explore deeper into an area rather than progressing further ahead of the

Teacher's plan (3.4.3) especially when jazzed up Students search for extension work (3.4.7). Table 23 shows the Theme under Code Group 3: Teachers.

Table 23

Theme for Code Group 3: Teachers.

Theme 3	Code Group 3	Code Summary Heading
Teachers' 'knowledge' of their students allows them to dynamically connect the student's individual goals to the Curriculum's learning objectives, differentially assign them to ability groups and formatively record and feedback to students and their Parents.	Teachers	3.1 Ability Groups 3.2 Learning Objectives 3.3 Evidence 3.4 Extension 3.5 Reading-Literacy 3.6 Written Homework 3.7 Socioeconomic-Cultural 3.8 Homework Apps

Code Summary 3.2 - Learning Objectives

This code summary identifies two potential online collaborative solutions where a homework program should provide parents with learning objectives linked to their child's strengths that form a report for the teacher to comment on, and a homework program should measure a student's understanding, fluency and problem solving against learning objectives. Two positive sentiments are also identified where teachers set learning goals with students, so they know clearly where the teacher wants them to go to next, and some teachers provide summative feedback to parents at report time as an aggregated grade with general comments. The transcribed exerts from Codes 3.2.2 and 3.2.3 demonstrate part of this.

Code 3.2.2 - A homework program should provide parents with learning objectives linked to their child's strengths that form a report for the teacher to comment on. (✓)

"Yeah, I guess it would be useful and if the parents knew the learning objective – because that's probably something we haven't shared with – we don't really share with them. So, if they knew exactly the learning objective with the links to their strength…"

(Participant 0201)

"It's true because it's all through our planning, everywhere. Every lesson has a learning intention or yeah, learning objective and then how you plan to achieve that in the lesson. So that's - yeah, it's interesting and none of our reporting has anything like that either to indicate whether they have achieved or haven't. Our reporting is a comment and a grade and some general sentences about how they've done."

(Participant 0202)

Code 3.2.3 - A homework program should measure a student's understanding, fluency and problem solving against learning objectives. (✓)

"Each question, I said to my kids, I'm looking for three things. I'm looking that: 1) you can write for me a number sentence 2) you're drawing me a picture and you're showing me your working and 3) I'm looking for the answer. If I don't get those three things, you don't get the question right. Because if they can't show their working or demonstrate their understanding, we don't know that they can do it."

(Participant 0302)

Code Summary 3.3 - Evidence

This code summary identifies four potential online collaborative solutions where video can be used as evidence, photos can be used as evidence, there is no app that provides evidence, and a homework program should retain digital evidence of a task set by a teacher based on a learning objective that shows a student's progress/success and dynamically accrues that data to their report card. The transcribed exerts from Codes 3.3.1 and 3.3.4 demonstrate part of this.

Code 3.3.1 - Video can be used as evidence. (✓)

"The other thing that we did in terms of getting things done at home and at school was that they were taking photos as evidence of work that they were doing and then they were submitting it and then I was able to give them feedback.” (Participant 0102)

Code 3.3.4 - A homework program should retain digital evidence of a task set by a teacher based on a learning objective that shows a student's progress/success and dynamically accrues that data to their report card. (✓)

“So, if you could - say a task that you’d set and it was based - meeting a learning objective and if you could see they were successful with it, that it then kept track and recorded that they had been successful with that. Then when you went to do their report cards, you could see yep, what they – or just to then know, to inform your teaching. So that would be valuable. (Participant 0201)

“Retaining a form of digital evidence would be valuable? Yeah. (Participant 0202)

Code Summary 3.4 - Extension

This code summary identifies three potential online collaborative solutions where a homework program should allow teachers the option to provide a student an additional activity, teachers have to manually differentiate a student's ability levels and stream them into either lower, mainstream, or extension ability groups for maths, and a homework program should direct enquiring students to Explore deeper into an area rather than progressing further ahead of the teacher's plan. The transcribed exerts from Codes 3.4.1, 3.4.3, and 3.4.7 demonstrate part of this.

Code 3.4.1 - A homework program should allow teachers the option to provide a student an additional activity. (✓)

“… and then upload the task and we could put - as an additional activity, not as an extension activity, as an additional activity, if you would like to, and then they could choose whether they did that or not.”

(Participant 0202)

Code 3.4.3 - A homework program should direct enquiring students to explore deeper into an area rather than progressing further ahead of the teacher's plan. (✓)

“English has all graded levels of reading but as teachers, we can unlock different levels. So, if you have something similar to that for maths, where, as you progress along the line, you can unlock different homework. So, then you will always have homework that’s on your level.”

(Participant 0301)

“Yes, that’d be good.”

(Participant 0302)

Code 3.4.7 - Jazzed up students search for extension work as a matter of course. (+)

“Those children that are jazzed about wanting to know more or a parent who’s wanting to give their child more information, I think they already search for the extension work anyway.

(Participant 0101)

4.3.4 Theme 4 – Code Group 4: Parent-Child Collaboration

Theme 4 represents those codes where Teachers acknowledged hands-on evidence of a Student’s ability as paramount before they could trust extending them to a new ability group through Parental collaboration. The central hub of these codes was Feedback (4.2) as Teachers seek to provide specific individualised feedback formatively to Parents and Students. Of particular support noted from the Participants (✓) was that a homework program should allow Parents to provide feedback on how their child worked at home on a task and for Teachers to then feedback to the Parent (4.2.1) and numerically and visually isolate for a Parent a Student's achievement or ability at home that mirrors the tasks set in class (4.2.2). Furthermore, a homework program that formatively links to the learning objectives set by the Teacher that identifies a Student's ability (from their work at home) based on the Curriculum's Achievement Standards would save a Teacher time and allow them to select a judgement comment from a list that could provide feedback/guidance to a Parent on where they can specifically help their child (4.2.3). While it may appear that hands-on manipulatives are contrary to the idea of an ‘online system’, in that they are not a technology solution per se, the Participants stressed that hands-on manipulatives (4.3.4) are a necessary feature that would need to be factored into a design specification in order to drive homework from the classroom (4.4.14). Table 24 shows the Theme under Code Group 4: Parent-Child Collaboration.

Table 24

Theme for Code Group 4: Parent-Child Collaboration.

Theme 4	Code Group 4	Code Summary Heading
Teachers need hands-on proof of a student’s ability before they trust extending them to a new Ability Group.	Parent-Child Collaboration	4.1 Collaboration 4.2 Feedback 4.3 Hands-On and Manipulatives 4.4 Homework in Context 4.5 Incidental Maths 4.6 Video-Photo

Code Summary 4.2 - Feedback

This code summary identifies four positive sentiments for feedback where a homework program should allow parents to provide feedback on how their child worked at home on a task and for teachers to then feedback to the parent, a homework program should numerically and visually isolate for a parent a student's achievement/ability at home that mirrors the tasks set in class to feedback and enable a parent to help their child formatively and retrospectively, a homework program that formatively links to the Learning Objectives set by the teacher that identifies a student's ability (from their work at home) based on the Curriculum's Achievement Standards would save a teacher time and would allow them to select a judgement comment from a list that could provide feedback/guidance to a parent on where they can specifically help their child, and a homework program should make it easy to feedback to a parent and student if they are doing well and offer them more challenging extension tasks. The transcribed exerts from Codes 4.2.1, 4.2.2, and 4.2.2 demonstrate part of this.

Code 4.2.1 - A homework program should allow parents to provide feedback on how their child worked at home on a task and for teachers to then feedback to the parent. (✓)

> "So maybe having some type of capability in there where it does – like there is feedback from parents. They can provide a little bit of feedback to us about how their kid had with or any problems they had so then you know that the parents are working with them on it… and then that gives them feedback as well about how they're going at home and then yeah, that might help know that parents are supporting them and it gives you a little bit of insight… Yeah and then that does bring in that collaboration with parents."
> (Participant 0201)

Code 4.2.2 - A homework program should numerically and visually isolate for a parent a student's achievement/ability at home that mirrors the tasks set in class to feedback and enable a parent to help their child formatively and retrospectively. (✓)

> "So, parents can see how well their child has done on particular homework concepts. They can see percentages. So maybe in the sense that if there was a program that could isolate your child's achievement with the tasks they've been set, so only those parents can see. A bit like ClassDojo did that only those parents can just [see their] child, no one else's. That would be beneficial because they can see – look up their child, and they can see what they've done. They can see any percentages that perhaps were falling in the red and if they chose to, that could be an area of revision. That they could take that on board, and they could go over those concepts with them, you know? Or if there was a couple of things that they could go back and [unclear] help them, they could but I don't know how many people - parents would do that, though."
> (Participant 0202)

Code 4.2.3 - A homework program that formatively links to the learning objectives set by the teacher, which identifies a student's ability (from their work at home) based on the Curriculum's Achievement Standards, would save a teacher time and would allow them to select a judgement comment from a list that could provide feedback/guidance to a parent on where they can specifically help their child. (✓)

> “Yeah, I guess it would be useful if the parents knew the learning objective – because that’s probably something we haven’t shared with – we don’t really share with them. So, if they knew exactly the learning objective with the links to their strength. So, if they’ve done a task at home… and then we can see what they’ve done and then have to give - so it would be like - kind of like having a comment bank where we each can look at what they’ve done and choose – instead of having to provide – come up with feedback, see what they’ve done and maybe just a certain area for a focus for improvement. Or something they’ve done well, something they need to work on. Say they’re doing something with coins, money, and they have to identify the values or do - add the money up to make a total. We could just - see, our stuff is very - like stuff that parents would hopefully be able to see but somehow where we don’t have to put in the comment but there’s just different things based on the achievement standard. The area that they didn’t do well or something they need to work on and we could just click a box and it sends that feedback.”
> (Participant 0201)

Code Summary 4.3 - Hands-On and Manipulatives

This code summary identifies nine positive sentiments for hands-on manipulatives where: hands-on and manipulatives provide real-life experiences in maths homework and is superior to screen based learning; homework should be hands-on, manipulative, touching, feeling, moving, drawing; manipulatives can be blocks, beads, fake money, calculators, whiteboards; hands-on and manipulatives provide real-life experiences in maths homework and is superior to screen-based learning; manipulatives help students understand mathematics better because they enable them to see why maths happens; manipulatives enable students to see there is more than one way to go about solving a mathematics problem; manipulatives give students the experience of working out their own strategies; manipulatives allow a teacher to see how a student is going about solving a problem; and a teacher can take a photo of things for parents that demonstrates patterning with concrete resources, manipulatives, and MAB blocks. The transcribed exert from Code 4.3.4 demonstrates part of this.

Code 4.3.4 - Students need a mix of Hands-On and technology, but they should primarily learn maths by actually 'doing' and handling materials. (+)

> “Using technology, I think is good, but we need a mix for these kids for hands-on but also in terms of when they’re learning it, actually doing it, as well… like say they’re doing 10s and ones and making numbers. For our kids, yes, all well and good seeing a stick of 10 - but actually having materials and making groups of 10, that’s so important.”
> (Participant 0201)

Code Summary 4.4 - Homework in Context

This code summary identifies eleven positive sentiments for homework in context where: parents are encouraged to do incidental maths homework; colouring a section of homework is an extension task; homework is based on what is being learned in the classroom; homework is an extension of what is being taught in class; homework always relates to what is being done in class; teachers can negotiate with students to use technology in homework; teachers can target maths homework to be more collaborative especially if parents see their child struggling; teachers expect students to take charge of setting up homework supervised by their parents; homework is a routine to continue practicing class work; homework helps a student's understanding of maths through routines; and homework should be based on what is taught in class, so it is familiar, relatively easy, and not new. The transcribed exert from Code 4.4.14 demonstrates part of this.

Code 4.4.14 - Homework should be based on what is taught in class, so it is familiar, relatively easy, and not new. (+)

> "It's all based on what we've done in class so nothing should be new. It all should be familiar, and it should be relatively easy and that's what you're aiming for but you definitely you can individually give kids easier, core to mathematics or the extension and that's what we do for our kids."
> (Participant 0202)

4.3.5 Theme 5 – Code Group 5: Teacher-Parent Collaboration

Theme 5 identifies Teacher suspicion that Parental contribution in traditional homework methods can subvert a Teacher's homework plan and the Student's learning process, rendering any measurement of learning negotiable and a waste of time for all parties. The participants roughly equal positive (+) and negative (-) sentiments towards collaboration (5.2 *Parental Collaboration*) shows that while they believe Parents are keen to learn (5.2.6) and they are keen to help willing Parents (5.2.11), a contrast becomes apparent when time constraints start to impose on Parents (5.3 *Time*). The sentiment echoed throughout these codes was that a homework system would have to offer a bridge to enable them to trust that their time is not wasted delivering homework in futility (5.3.3). Table 25 shows the Theme under Code Group 5: Teacher-Parent Collaboration.

Table 25

Theme for Code Group 5: Teacher-Parent Collaboration.

Theme 5	Code Group 5	Code Summary Heading
Teachers are suspicious that Parental contribution in traditional homework methods subverts the Teacher's homework plan and the student's learning process, rendering any measurement of learning negotiable and a waste of time for all parties.	Teacher-Parent Collaboration	**5.1 Teachers Teaching Parents*** 5.2 Parental Collaboration 5.3 Time

Code Summary 5.1 - Teachers Teaching Parents

This code summary identifies four negative sentiments for teachers teaching parents where: parents often understand concepts but with different terminology; teachers are mindful not to be too onerous when teaching parents who are very time-poor; teachers are frustrated and see it as harmful when parents try to teach their children things other than what the child is expected to be doing and without any application to a maths problem, as it is often based on how the parent learned the concept; and some parents want the teacher to teach to help with homework, while others want the teacher to take care of the education. The transcribed exerts from Code 5.1.3 and 5.1.4 demonstrate part of this.

Code 5.1.3 - Teachers are mindful not to be too onerous when teaching Parents who are very time-poor. (-)

> "Parents do come and ask us, what can we be doing at home to help? That's - you always get that. What can we do with them to help? What can we do? You tell them these things and then the next thing you hear from them is oh, we didn't have time to do this, we didn't."
> (Participant 0201)

Code 5.1.4 - Teachers are frustrated and see it as harmful when Parents try to teach their children things other than what the child is expected to be doing and without any application to a maths problem, as it is often based on how the parent learned the concept. (-)

"We do sometimes have parents who think they are helping, but because they don't know what the kids are expected to be doing, they will teach them times tables. It's great to know your times tables like a parrot but if you can't apply it to a maths problem, then you're actually doing more harm, I think."
(Participant 0301)

Code Summary 5.2 - Parental Collaboration

This code summary identifies ten positive sentiments for parental collaboration where: teachers encourage parents to skip count, single-digit addition and subtraction; parents are encouraged to do incidental maths while kids are in the bath or in the car; parents can set drills at home based on drills in the classroom; teachers can target maths homework to be more collaborative especially if parents see their child struggling; teachers can use synchronous apps to teach a parent one-on-one with examples to help them understand concepts; teachers expect students to take charge of setting up homework supervised by their parents; teachers can ask parents to help their child to practice at home something the child is focusing on or struggling with to reinforce it; videos for parents to watch can help them understand the concepts the students are doing for homework; teachers often have to find ways to help parents so that they are supporting what the teacher does; and teachers value students interacting and spending time with their parents more than extra homework. The transcribed exerts from Code 5.2.6, 5.2.11, 5.2.18 and 5.2.22 demonstrate part of this.

Code 5.2.6 - Parents are keen to learn. (+)

"The parents are keen to learn to be able to help their children. They want to help their children."
(Participant 0102)

Code 5.2.11 - Teachers often have to find ways to help Parents so that they are supporting what the Teacher does. (+)

"If someone was having difficulties with the work, that's where we could then discuss through and you could be a lot more personal and say, well the words that your child needs to use are these words. If that's too much, just try just doing five, that's all they need to submit and really talk through how to then modify the plan, I guess. I did that for a couple of kids. Then support the parents to do that and ask questions – and if the parents had questions of how to do things, we would support them by explaining this is how we teach the concept."

(Participant 0201)

Code 5.2.18 - Teachers don't want to be pushy with parents pushing homework onto kids. (-)

"We just have to be aware that everything has a balance, so we don't be pushy with our parents because children these days are doing more than just – they're doing Oztag, or they're doing music, or they're doing dance, and things like that, so we have to have a level of flexibility and allow the parent to go, well – because I have some parents who just say, I just want my child to be a child."

(Participant 0101)

Code 5.2.22 - Parents will sometimes try and help but without understanding how it is being taught by the Teacher and potentially undoing what has been taught to the Student. (-)

"I'm not a huge homework fan in that sense because of the kids work hard at school but also parents sometimes will try and help and they don't understand and will do it all – like undo what we've done. So, it's trying to find a way to help parents so that they're supporting what we do."

(Participant 0201)

Code Summary 5.3 - Time

This code summary identifies two negative sentiments for time where: teachers try to keep homework from being onerous and time demanding of the parent and student; and teachers who work overtime helping parents with ways to support their child at home can be dismayed when the parent then fails to make time to take the action. The transcribed exert from Code 5.3.2 demonstrates part of this.

Code 5.3.2 - Teachers try to keep homework from being onerous and time demanding of the parent and student. (-)

> "Then I've got students who are going further than that who are doing multiplication or division, so that's just a really quick, easy thing for the parents because I try not to make anything too onerous because they won't do it because they're too busy." (Participant 0101)

4.4 Phase Four: Naming Themes and Developing a Thematic Map

In this phase the Researcher reviewed the themes, named them, and generated a code structure map of the analysis for each theme. The Researcher reviewed the Themes against their respective codes to develop Theme Names or an identity that could succinctly distinguish the meaning behind the Theme itself. Braun and Clarke noted that at some point the Researcher needs to "decide and develop the particular themes that work best for their project" during multiple analysis (Braun & Clarke, 2021, p. 7). With this in mind, the Researcher understands that the theoretical and philosophical underpinnings coupled with the aims and purpose of the analysis, to identify the necessary features for an online collaborative homework system, can delimit the promise of developing perfect Themes. Many of the theme's codes came from participant answers across questions in the interview and the themes are ordered in such a way so they could tell the story even if a theme was taken away.

4.4.1 Theme Name 1: Teachers Defend the Curriculum

Table 26 identifies the name for Theme 1 as *Teachers Defend the Curriculum*, and combines this with Theme 1, Code Group 1, and its associated Code Summary Headings.

Table 26

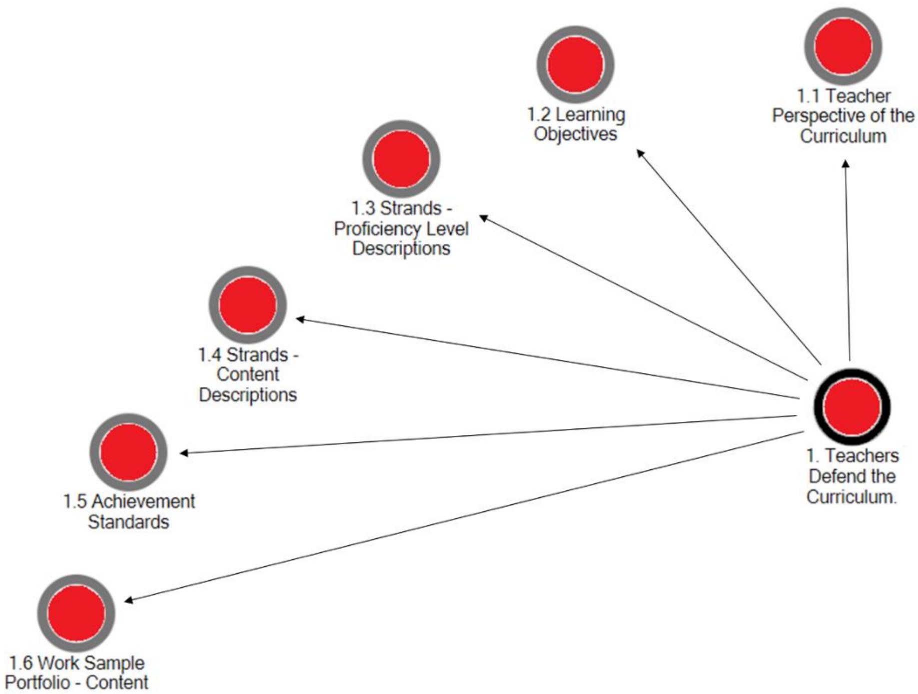
Theme Name for Theme 1: Teachers Defend the Curriculum.

Theme Name 1	Theme 1	Code Group 1	Code Summary Heading
Teachers Defend the Curriculum	Teachers appreciate the Curriculum but grapple with it being either too generalised in some areas and too specific in others, and stress that without their training and experience Parents are unable to fully understand and interpret it.	The Curriculum	1.1 Teacher Perspective of the Curriculum 1.2 Learning Objectives 1.3 Strands - Proficiency Level Descriptions 1.4 Strands - Content Descriptions 1.5 Achievement Standards 1.6 Work Sample Portfolio – Content

Figure 21 graphically shows a thematic map of Theme Name 1: *Teachers Defend the Curriculum*, with its associated Code Summary Headings.

Figure 21

Thematic Map of Theme Name 1: Teachers Defend the Curriculum, and associated Code Summary Headings.



4.4.2 Theme Name 2: Learning Starts in the Classroom

Table 27 identifies the name for Theme 2, and combines this with Theme 3, Code Group 2, and its associated Code Summary Headings.

Table 27

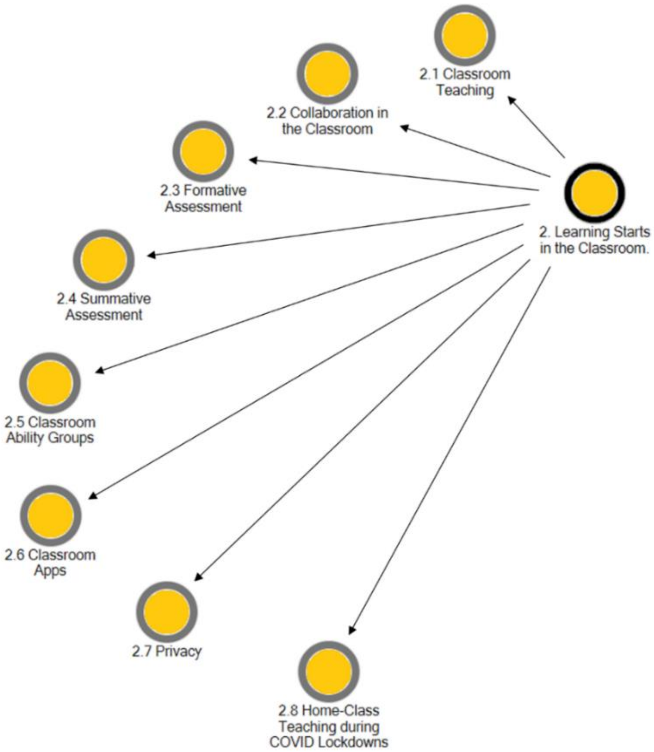
Theme Name for Theme 2: Learning Starts in the Classroom.

Theme Name 2	Theme 2	Code Group 2	Code Summary Heading
Learning Starts in the Classroom	Teachers' 'knowledge' of their students allows them to dynamically connect the student's individual goals to the Curriculum's learning objectives, differentially assign them to ability groups and formatively record and feedback to students and their Parents.	The Classroom	2.1 Classroom Teaching 2.2 Collaboration in the Classroom 2.3 Formative Assessment 2.4 Summative Assessment 2.5 Classroom Ability Groups 2.6 Classroom Apps 2.7 Privacy 2.8 Home-Class teaching During COVID Lockdowns

Figure 22 graphically shows a thematic map of Theme Name 2 with its associated Code Summary Headings.

Figure 22

Thematic Map of Theme Name 2: Learning Starts in the Classroom, and associated Code Summary Headings.



4.4.3 Theme Name 3: A Teachers' Individual Methods have to be Trusted

Table 28 identifies the name for Theme 3, and combines this with Theme 3, Code Group 3, and its associated Code Summary Headings.

Table 28

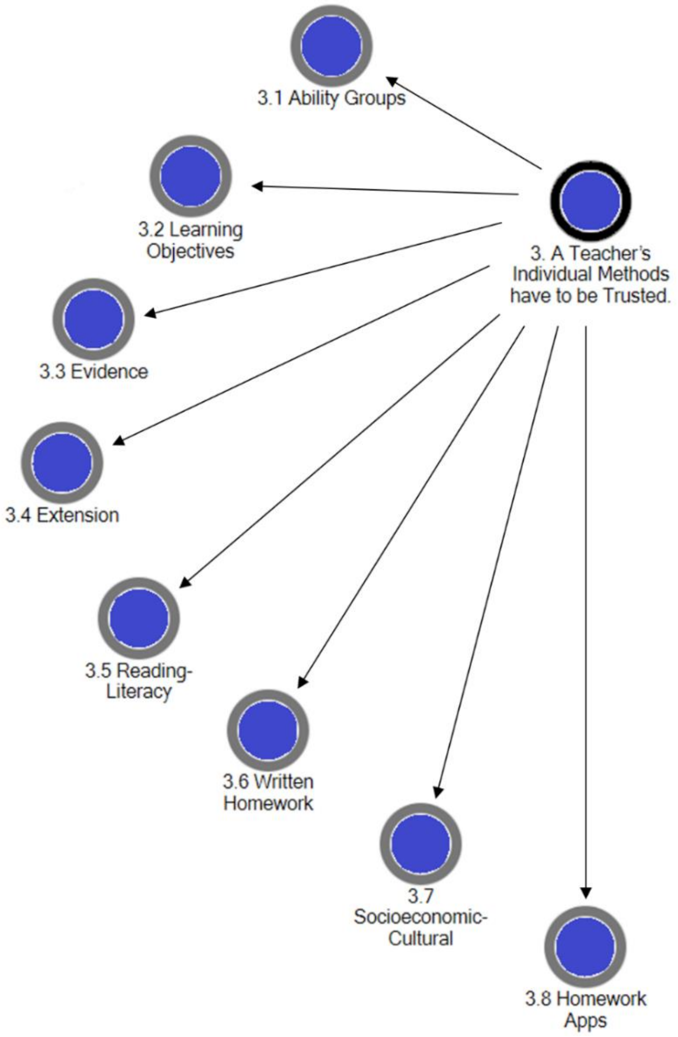
Theme Name for Theme 3: A Teachers' Individual Methods have to be Trusted.

Theme Name 3	Theme 3	Code Group 3	Code Summary Heading
A Teachers' Individual Methods have to be Trusted	Teachers' 'knowledge' of their students allows them to dynamically connect the student's individual goals to the Curriculum's learning objectives, differentially assign them to ability groups and formatively record and feedback to students and their Parents.	Teachers	3.1 Ability Groups 3.2 Learning Objectives 3.3 Evidence 3.4 Extension 3.5 Reading-Literacy 3.6 Written Homework 3.7 Socioeconomic-Cultural 3.8 Homework Apps

Figure 23 graphically shows a thematic map of Theme Name 3 with its associated Code Summary Headings.

Figure 23

Thematic Map of Theme Name 3: A Teachers' Individual Methods have to be Trusted, and associated Code Summary Headings.



4.4.4 Theme Name 4: Teachers encourage Parent-Child Collaboration to Engage and Record Ability

Table 29 identifies the name for Theme 4, and combines this with Theme 4, Code Group 4, and its associated Code Summary Headings.

Table 29

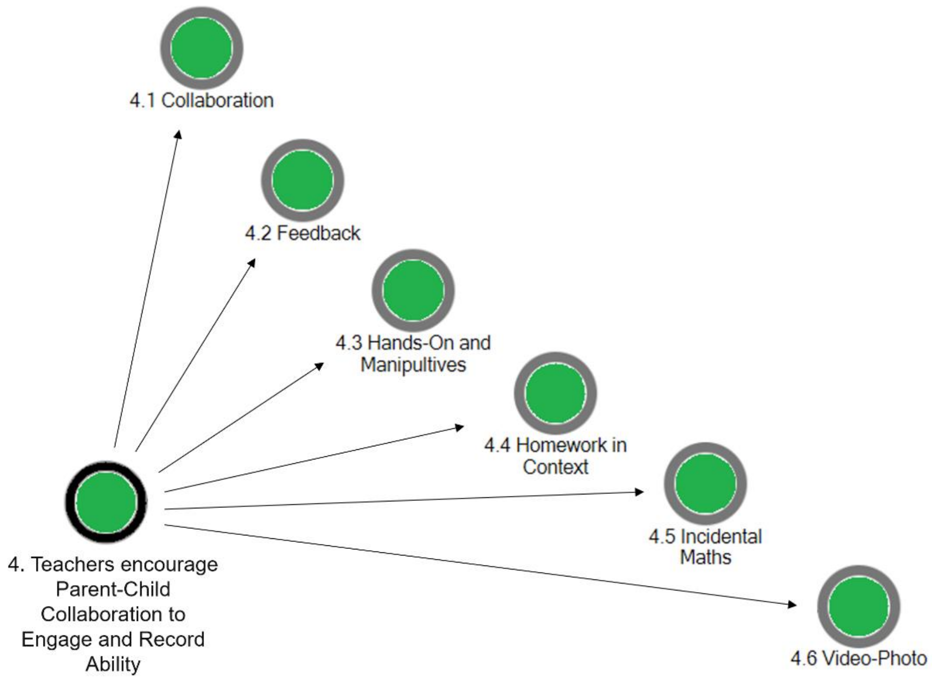
Theme Name for Theme 4: Teachers encourage Parent-Child Collaboration to Engage and Record Ability.

Theme Name 4	Theme 4	Code Group 4	Code Summary Heading
Teachers encourage Parent-Child Collaboration to Engage and Record Ability	Teachers need hands-on proof of a student's ability before they trust extending them to a new Ability Group.	Parent-Child Collaboration	4.1 Collaboration 4.2 Feedback 4.3 Hands-On and Manipulatives 4.4 Homework in Context 4.5 Incidental Maths 4.6 Video-Photo

Figure 24 graphically shows a thematic map of Theme Name 4 with its associated Code Summary Headings.

Figure 24

Thematic Map of Theme Name 4: Teachers encourage Parent-Child Collaboration to Engage and Record Ability, and associated Code Summary Headings.



4.4.5 Theme Name 5: Teacher-Parent Collaboration has to Overcome Significant Disconnect to make Homework Functional

Table 30 identifies the name for Theme 5, and combines this with Theme 5, Code Group 5, and its associated Code Summary Headings.

Table 30

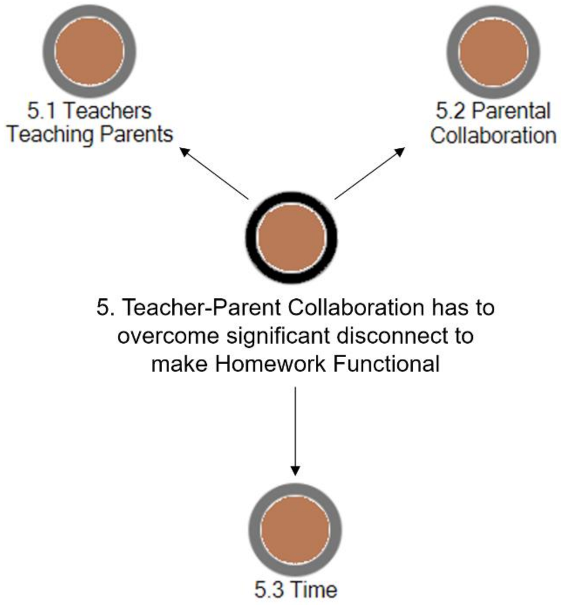
Theme Name for Theme 5: Teacher-Parent Collaboration has to overcome significant disconnect to make Homework Functional.

Theme Name 5	Theme 5	Code Group 5	Code Summary Heading
Teacher-Parent Collaboration has to overcome significant disconnect to make Homework Functional	Teachers are suspicious that Parental contribution in traditional homework methods subverts the Teacher's homework plan and the student's learning process, rendering any measurement of learning negotiable and a waste of time for all parties.	Teacher-Parent Collaboration	**5.1 Teachers Teaching Parents** 5.2 Parental Collaboration 5.3 Time

Figure 25 graphically shows a thematic map of Theme Name 5 with its associated Code Summary Headings.

Figure 25

Thematic Map of Theme Name 5: Teacher-Parent Collaboration has to overcome significant disconnect to make Homework Functional, and associated Code Summary Headings.



4.5 Phase Five: Refining and Defining Themes

Table 31 combines the Themes with their respective Theme Names and references to their associated table in Appendix F.

Table 31

Guide to Appendix F - Themes under their Associated Theme Name

Appendix	Theme Name	Theme
Table F1	1. Teachers Defend the Curriculum.	Teachers appreciate the Curriculum but grapple with it being either too generalised in some areas and too specific in others, and stress that without their training and experience Parents are unable to fully understand and interpret it.
Table F2	2. Learning Starts in the Classroom.	Teachers see their classroom as the hub from where they can drive learning by mixing students with different abilities and formatively assessing them.
Table F3	3. A Teachers' Individual Methods have to be Trusted.	Teachers' 'knowledge' of their students allows them to dynamically connect the student's individual goals within the Curriculum's learning objectives.
Table F4	4. Teachers encourage Parent-Child Collaboration to Engage and Record Ability.	Teachers need hands-on proof of a student's ability before they trust extending them to a new Ability Group.
Table F5	5. Teacher-Parent Collaboration has to Overcome Significant Disconnect to make Homework Functional.	Teachers are suspicious that Parental contribution in traditional homework methods subverts the Teacher's homework plan and the student's learning process, rendering any measurement of learning negotiable and a waste of time for all parties.

This chapter provided a step-by-step application of Braun and Clarke's (2021) Reflexive Thematic Analysis (RTA) to this study's data of paired depth interview transcribed data. Section 4.1 outlined RTA phase 1: data familiarisation and writing familiarisation notes. Section 4.2 outlined RTA phase 2: systemic data coding. Section 4.3 outlined RTA phase 3: generating initial themes from coded and collated data. Section 4.4 outlined RTA phase 4: naming themes and developing a thematic map. Section 4.5 outlined RTA phase 5: refining and defining themes.

5. FEATURE IDENTIFICATION, DISCUSSION, RECOMMENDATIONS, AND CONCLUSION

Introduction

Chapter 1 of this study opened with an argument for why improved mathematics development at Year 1 is useful and important both for the individual student and Australia as a global economic competitor. This was followed in Chapter 2 with a literature review that explored and evaluated: the learning relationships students have with their parent(s) and teacher; educational theories for application development; educational theories for application measurement; and a précis of appropriate system design and development methods that would need to be understood to identify the features needed for an online collaborative learning system for mathematics at Year 1. This review provided the Researcher with the foundation to determine the research question:

> What features are necessary to design an online collaborative homework support system for Australian Year 1 Mathematics?

To support this question, this study sought to answer three further sub-research questions:

1. Barriers - what barriers exist that could impede implementation of the features?
2. Interface – how could the features interface between the Curriculum and users to overcome the barriers?
3. Existing Applications - what Year 1 mathematics applications are currently available, either in the Curriculum or stand-alone, that are used by teachers that contain any of the features?

With this research question and sub-questions, the Researcher identified a suitable methodology to use to gather the appropriate data in Chapter 3. The results of the analysis of the data collected through a step-by-step application of Braun and Clarke’s (2021) Reflexive Thematic Analysis to this study’s data of paired depth interviews of qualified Teacher/Participants in Chapter 4 produced five themes.

In this chapter the themes are linked to the research question in section 5.1. In section 5.2 the features from the Participant/Teacher's perspective for a collaborative online homework system are identified. Section 5.3 identifies the barriers to developing the features into a collaborative online homework system, and section 5.4 provides recommendations to overcome those barriers. Section 5.5 identifies the existing applications provided in the Curriculum and those used by the Participants to review whether any provide the required features.

5.1 Linking Themes to the Research Question

Table 32 articulates the themes developed from the analysis as applied to the research question to provide a rich connection from the dialogue of the Participants to the aim of this study.

Table 32

Defining Themes in Relation to the Research Question.

Theme Name	Themes Associated to the Research Question
1. Teachers Defend the Curriculum.	**Theme:** Teachers appreciate the Curriculum but grapple with it being either too generalised in some areas and too specific in others, and stress that without their training and experience Parents are unable to fully understand and interpret it.
	Research Question Application: A collaborative online homework system would need features that conduit the Curriculum for Teachers' needs but operate in the background for parents.
2. Learning Starts in the Classroom.	**Theme:** Teachers see their classroom as the hub from where they can drive learning by mixing students with different abilities and formatively assessing them.
	Research Question Application: A collaborative online homework system would need features that could differentially and dynamically branch from the classroom learning through a private network to each home and to formatively inform back to the Teacher.
3. A Teachers' Individual Methods have to be Trusted.	**Theme:** Teachers' 'knowledge' of their students allows them to dynamically connect the student's individual goals within the Curriculum's learning objectives.
	Research Question Application: A collaborative online homework system would need features that adjunct a Teacher's knowledge, differentially assigning students to ability groups, formatively recording and feeding back to students and their parents.

Theme Name	Themes Associated to the Research Question
4. Teachers encourage Parent-Child Collaboration to Engage and Record Ability.	**Theme:** Teachers need hands-on proof of a student's ability before they trust extending them to a new Ability Group.
	Research Question Application: A collaborative online homework system would need features that digitally store evidentiary proof of a student's hands-on manipulative homework contribution.
5. Teacher-Parent Collaboration has to Overcome Significant Disconnect to make Homework Functional.	**Theme:** Teachers are suspicious that Parental contribution in traditional homework methods subverts the Teacher's homework plan and the student's learning process, rendering any measurement of learning negotiable and a waste of time for all parties.
	Research Question Application: A collaborative online homework system would need features that restore trust by empowering parents with time quantifiable consumable tasks that set up manipulative exercises that can measure a student's ability to inherently promote functional homework.

5.2 Identifying the Features required for a Collaborative Online Homework System

As the analysis brought teachers front and centre into conversation, this discussion and conceptual application, essentially argues not just from a teacher's perspective but on behalf of teachers to identify the features necessary to design an online collaborative homework system for Year 1 mathematics. This is because the teacher is the driver/nexus that ignites the potential for a student's success. As an allegory from computer science terminology, teachers are the 'bootstrapper' for learning transfer, where bootstrapping is a skill of loading a program into a computer by way of a few initial instructions which facilitate the introduction of the rest of the program from an input machine. Applying the user-centred design method (Fridman, 2021c), the Researcher has sought to identify features for an online collaborative homework system as being teacher-centred and meaningful by including the Participant/Teachers' thoughts and feelings (Sizemore, 2018) as they would be the primary catalytic users. Tables 33-37 associate 16 features alongside the corresponding themes identified from the analysis.

5.2.1 Features from Theme 1: Teachers Defend the Curriculum

The first theme identified that the Participants appreciate the Curriculum but grapple with it being either too generalised in some areas and too specific in others, and stress that without their training and experience Parents are unable to fully understand and interpret it. This is in line with the research in the literature review. For example, the Curriculum promotes concepts such as ability groups (Slavin, 1980), however, the form of ability grouping that the Curriculum uses is quite complex for parents to understand in that it applies ability grouping through example work sample portfolios: satisfactory; above satisfactory; and below satisfactory (Section 2.3.2). This type of complexity has contributed to them being a controversial issue in schools (Glass, 2002) in large part because of the difficulty in applying them to an ever-changing level of student mastery and matching that to a varying curriculum. Most importantly, the frustrating component for parents is the Curriculum's use of the term 'satisfactory' as the axis for ability group categorisation of students in that it is inherently teacher centric, arbitrary, and not easily consumable for students and parents. In addition, the Curriculum obstructs a parents' ability to see any measurement of a student's proficiency in that it provides only a general measurement that can only be discovered through the lens of the term *proficiency* and that is buried within the *level description* (see Appendix C, Figure C3).

Applied to the research question, a collaborative online homework system would therefore require features that conduit the Curriculum for Teachers' needs but operate in the background for parents. To facilitate these requirements, teachers would need to be able to:

1. Identify learning objectives that are defined and matched to the Curriculum
2. Select learning objectives from a database to deliver as homework

exercises.

Table 33 interprets 2 features from Theme 1 and its application to the research question.

Table 33

Features Identified from Theme 1 in Relation to the Research Question.

Theme Name	Features developed from Themes associated to the Research
1. Teachers Defend the Curriculum.	**Theme:** Teachers appreciate the Curriculum but grapple with it being either too generalised in some areas and too specific in others, and stress that without their training and experience Parents are unable to fully understand and interpret it.
	Research Question Application: A collaborative online homework system would require features that conduit the Curriculum for Teachers' needs but operate in the background for parents.
	Features: 1.1 Teachers can identify **learning objectives** that are defined and matched to the Curriculum. 1.2 Teachers can select **learning objectives** from a database to deliver as homework exercises.

5.2.2 Features from Theme 2: Learning Starts in the Classroom

The second theme identified that the Participants see their classroom as the hub from where they can drive learning by mixing students with different abilities and formatively assessing them. This lines up with the research in the literature review. For example, formative feedback is considered the 'most powerful factor in promoting learning in the 21^{st} century' (Black & Wiliam, 1998a; Black & Wiliam, 1998b; Johannesen, 2013; Nicol & Macfarlane-Dick, 2006). In the class setting, Wiliam (2018) describes assessment as acting in a formative way where evidence of a student's achievement is prompted, understood, and utilised by teachers, learners, or their peers to make choices regarding the next steps in instruction that are likely to be better than choices that might have been made without that evidence. The Australian Curriculum, though, provides no obvious format for formative feedback to be collaboratively exchangeable with their child and their teacher and based on sound learning objectives.

Applied to the research question, a collaborative online homework system would therefore require features that could differentially and dynamically branch from the classroom learning through a private network to each home and to formatively inform back to the Teacher. To facilitate these requirements teachers would need to be able to:

1. Match learning objectives to an individual student based on their ability.
2. Select extensions to the learning objectives based on an individual student's ability
3. Select from a variety of strategic methods to form repetition to learning objectives
4. Select learning objectives to apply concrete/manipulative, representational, or abstract methods.

Table 34 interprets 4 features from Theme 2 and its application to the research question.

Table 34

Features Identified from Theme 2 in Relation to the Research Question.

2. Learning Starts in the Classroom.	**Theme:** Teachers see their classroom as the hub from where they can drive learning by mixing students with different abilities and formatively assessing them.
	Research Question Application: A collaborative online homework system would require features that enabled differentially and dynamically branch from the classroom learning through a private network to each home and to formatively inform back to the Teacher.
	Features: 2.1 Teachers can match **learning objectives** to an individual student based on their ability. 2.2 Teachers can select extensions to the **learning objectives** based on an individual student's ability. 2.3 Teachers can select from a variety of strategic methods to form repetition to **learning objectives.** 2.4 Teachers can select **learning objectives** to apply. concrete/manipulative, representational, or abstract methods.

5.2.3 Features from Theme 3: A Teachers' Individual Methods have to be Trusted

The third theme identified that the Participants 'knowledge' of their students allows them to dynamically connect the student's individual goals within the Curriculum's learning objectives. This confirms what was discovered in the literature review. For example, clearly constructed learning objectives provide guiding statements for each learning encounter, connecting the intention with the reality within the learning event as well as to the assessment planned (Chatterjee & Corral, 2017). Furthermore, well-written learning objectives outline the knowledge, skills and/or attitude a student will gain from an educational activity and are measurable (Chatterjee & Corral, 2017). However, the Curriculum does not explicitly or implicitly define or break down learning objectives into its components such as the model defined by Arreola (1998), so this makes their application an esoteric technique used by teachers.

Applied to the research question, a collaborative online homework system would therefore require features that adjunct a Teacher’s knowledge, differentially assigning students to ability groups, formatively recording and feeding back to students and their parents. To facilitate these requirements teachers would need to be able to:

1. Feedback to students about their progress from their actual level of development to higher levels of development through learning outcome statements.
2. Verify learning outcome statements from actual level of development to a higher level of development.

Table 35 interprets 2 features from Theme 3 and its application to the research question.

Table 35

Features Identified from Theme 3 in Relation to the Research Question.

3. A Teachers' Individual Methods have to be Trusted.	**Theme:** Teachers' 'knowledge' of their students allows them to dynamically connect the student's individual goals within the Curriculum's learning objectives.
	Research Question Application: A collaborative online homework system would require features that adjunct a Teacher's knowledge, differentially assigning students to ability groups, formatively recording and feeding back to students and their parents.
	Features: 3.1 Teachers can feedback to students about their progress from their actual level of development to higher levels of development through **learning outcome** statements. 3.2 Teachers can verify **learning outcome** statements from actual level of development to a higher level of development.

5.2.4 Features from Theme 4: Teachers encourage Parent-Child Collaboration to Engage and Record Ability

The fourth theme identified that the Participants need hands-on proof of a student's ability before they trust extending them to a new Ability Group. This correlates with the research in the literature review. Hands-on concrete-representational-abstract (CRA) teaching is a well-researched method that uses components of both explicit and strategy instruction models (Peterson, Mercer & O'Shea, 1998). Concrete/manipulative strategies employ tactile tools to help a student understand a concept or process through physical and visual engagement. Once a teacher sees that a student can master a problem and solution using hands-on manipulatives, the sequence of instruction continues to representational-level lessons that involve the use of drawings or tallies to solve similar sorts of problems. Once mastery is gained at the representational-level, the sequence of instruction progresses to abstract-level lessons that involves solving problems using mathematical or numerical symbols only (Mancl, Miller, & Kennedy, 2012). However, the Australian Curriculum provides no obvious format or instruction to provide evidentiary hands-on feedback of a student's ability that can be collaboratively exchanged between parent, student, and their teacher.

Applied to the research question, a collaborative online homework system would therefore require features that digitally store evidentiary proof of a student's hands-on manipulative homework contribution. To facilitate these requirements teachers would need to be able to:

1. See video evidence of a student's progression.
2. Feedback to students and parents to encourage movement through ability groups.
3. Quickly identify learning objectives' wording so that students can work independently from parental input.

Table 36 interprets 3 features from Theme 4 and its application to the research question.

Table 36

Features Identified from Theme 4 in Relation to the Research Question.

4. Teachers encourage Parent-Child Collaboration to Engage and Record Ability.	**Theme:** Teachers need hands-on proof of a student's ability before they trust extending them to a new Ability Group.
	Research Question Application: A collaborative online homework system would require features that digitally store evidentiary proof of a student's hands-on manipulative homework contribution.
	Features: 4.1 Teachers can see video evidence of a student's progression. 4.2 Teachers can feedback to students and parents to encourage movement through ability groups. 4.3 Teachers can quickly identify learning objectives' wording so that students can work independently from parental input.

5.2.5 Features from Theme 5: Teacher-Parent Collaboration has to overcome significant disconnect to make Homework Functional

The fifth theme identified that the Participants are suspicious that Parental contribution in traditional homework methods subverts the Teacher's homework plan and the student's learning process, rendering any measurement of learning negotiable and a waste of time for all parties. This correlates positively with the research in the literature review. For example, many teachers avoid homework (certainly for Year 1 students) and in some situations schools themselves set a "no homework" policy (Carmody, 2018, para. 2) despite that all teachers should be inspired to understand what good homework practices look like (Carmody, 2018). Part of this avoidance by teachers is that for students and their parents at primary level, terms such as learning objectives, learning outcomes, proficiency, and ability groups along with the myriad of mathematical terms contain no real conductive meaning (Fisher, 2020; Hogan, 2019; Mathnasium, 2016). In many instances it is the parents who are reticent to work with their children to complete homework (Hargis, 2015; Barish, 2012). This can be very discouraging for teachers. Many factors may contribute to this, however, the main driver of parental resistance is that homework delivery is not unified or easy for parents to deliver and synchronised at their child's level of development, which creates an unknown optimal time requirement of the parent (Anderson, 2016; Hamlin, 2019). This is further exacerbated as work responsibilities have changed over the generations where, in many instances, both parents work full-time, and there may be more than one child at home requiring parental assistance with homework (Shepherd, 2010).

Applied to the research question, a collaborative online homework system would therefore require features that restore trust by empowering parents with time quantifiable consumable tasks that set up manipulative exercises that can measure a student's ability to inherently promote functional homework. To facilitate these requirements teachers would need to be able to:

1. Access easy communication methods for Parents to assist homework activities.

2. Identify quantifiable timeframes for homework exercise development.
3. Easily communicate timeframes for homework delivery by parents.
4. Choose pre-selected or user-defined feedback to provide to parents in context.
5. Receive pre-selected or user-defined feedback from parents.

Table 37 interprets 5 features from Theme 5 and its application to the research question.

Table 37

Features Identified from Theme 5 in Relation to the Research Question.

5. Teacher-Parent Collaboration has to overcome significant disconnect to make Homework Functional.	**Theme:** Teachers are suspicious that Parental contribution in traditional homework methods subverts the Teacher's homework plan and the student's learning process, rendering any measurement of learning negotiable and a waste of time for all parties.
	Research Question Application: A collaborative online homework system would require features that restore trust by empowering parents with time quantifiable consumable tasks that set up manipulative exercises that can measure a student's ability to inherently promote functional homework.
	Features: 5.1 Teachers can access easy communication methods for Parents to assist homework activities. 5.2 Teachers can identify quantifiable timeframes for homework exercise development. 5.3 Teachers can easily communicate timeframes for homework delivery by parents. 5.4 Teachers can choose pre-selected or user-defined feedback to provide to parents in context. 5.5 Teachers can receive pre-selected or user-defined feedback from parents.

5.3 Barriers to Developing the Features Identified

Two main categories of demarcation delineate the list of features as:

1. Features requiring clearer *learning objectives*
2. Features requiring *improved trust* between teacher and parent.

Table 38 lists the features according to these categories of demarcation.

Table 38

Feature Categories.

Theme	Features Requiring Clear Learning Objectives	
1	1	Teachers can identify **learning objectives** that are defined and matched to the Curriculum.
	2	Teachers can select **learning objectives** from a database to deliver as homework exercises.
2	3	Teachers can match **learning objectives** to an individual student based on their ability.
	4	Teachers can select extensions to the **learning objectives** based on an individual student's ability.
	5	Teachers can select from a variety of strategic methods to form repetition to **learning objectives**.
	6	Teachers can select **learning objectives** to apply concrete/manipulative, representational, or abstract methods.
3	7	Teachers can feedback to students about their progress from their actual level of development to higher levels of development through **learning outcome** statements.
	8	Teachers can verify **learning outcome** statements from actual level of development to a higher level of development.
Theme	**Features Requiring Improved Trust between Teacher and Parent**	
4	9	Teachers can see video **evidence** of a student's progression.
	10	Teachers can **feedback** to students and parents to encourage movement through ability groups.
	11	Teachers can quickly identify learning objectives' wording so that **students can work independently from parental input**.

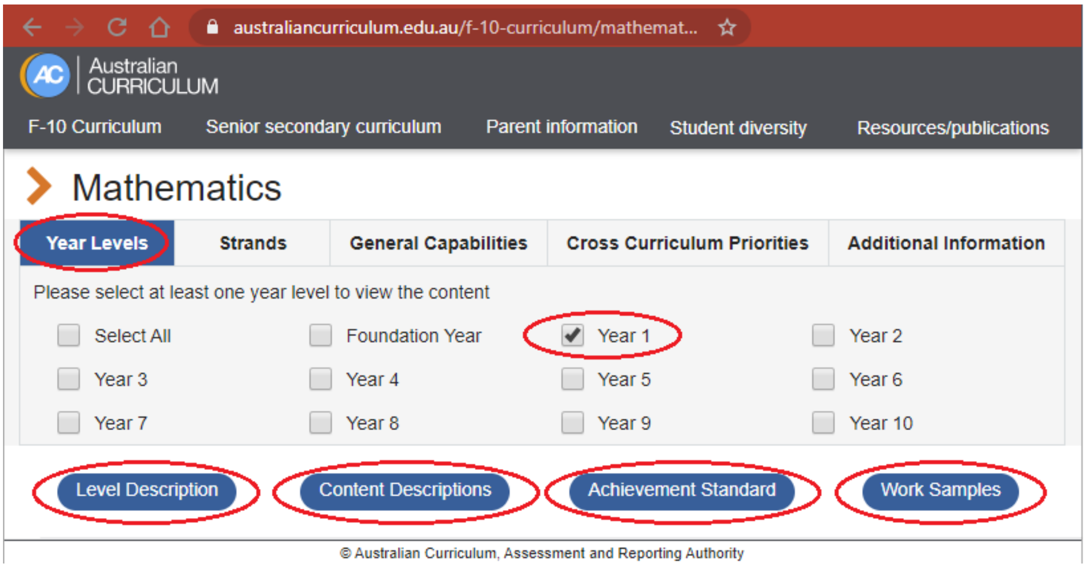
Theme	Features Requiring Improved Trust between Teacher and Parent	
5	12	Teachers can access **easy communication methods for Parents** to assist homework activities.
	13	Teachers can identify **quantifiable timeframes** for homework exercise development.
	14	Teachers can easily **communicate timeframes** for homework delivery by parents.
	15	Teachers can choose pre-selected or user-defined **feedback** to provide to parents in context.
	16	Teachers can receive pre-selected or user-defined **feedback** from parents.

5.3.1 Barriers to Clear Learning Objectives from the Curriculum

The first demarcated category centres on the requirement of clear learning objectives that would be needed to measure a student's progress against the Curriculum. The Researcher found that the Curriculum does not provide any obvious way for parents to connect the Proficiencies as stated in the Curriculum succinctly to any content, feedback, learning objectives, or learning outcomes. Without clearly defined learning objectives, any existing applications provided in the Curriculum or applications used by the Participants would have difficulty being adapted to produce meaningful learning outcomes. Figures 26 and 27 show screenshots of the Curriculum for mathematics at Year 1 and the range of options that can be selected but don't provide any clear sequence of Proficiency to objectives. Figure 26 shows the results of selecting Year 1 – 'Level Description', 'Content Description', 'Achievement Standards', 'Work Sample Portfolios'.

Figure 26

Year 1 in the Australian Mathematics Curriculum.

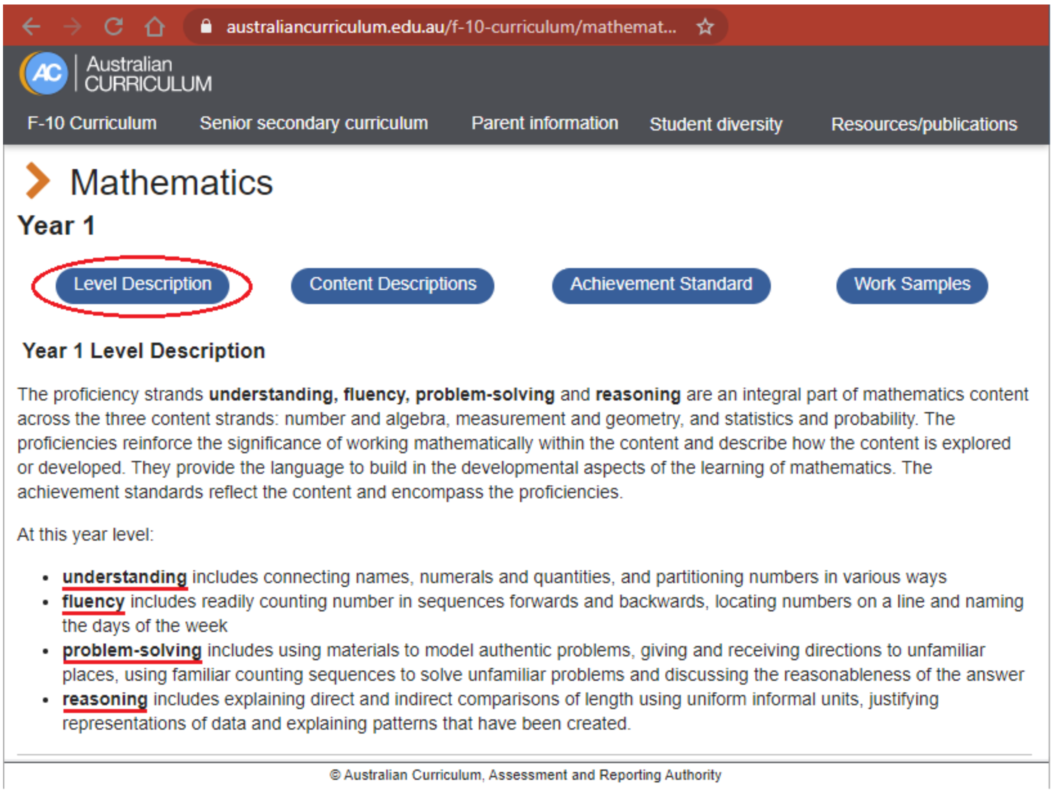


Note. From Australian Curriculum, 2021 (www.australiancurriculum.edu.au/f-10-curriculum/mathematics). © 2013 Australian Curriculum, Assessment and Reporting Authority, all rights reserved.

Figure 27 outlines the details for Year 1 ‘Level Description’ that identifies the Proficiency strands ‘understanding’, ‘fluency’, ‘problem-solving’ and ‘reasoning’.

Figure 27

Year 1 Level Description in the Australian Mathematics Curriculum.


australiancurriculum.edu.au/f-10-curriculum/mathemat...

Australian CURRICULUM

F-10 Curriculum | Senior secondary curriculum | Parent information | Student diversity | Resources/publications

Mathematics

Year 1

Level Description | Content Descriptions | Achievement Standard | Work Samples

Year 1 Level Description

The proficiency strands **understanding, fluency, problem-solving** and **reasoning** are an integral part of mathematics content across the three content strands: number and algebra, measurement and geometry, and statistics and probability. The proficiencies reinforce the significance of working mathematically within the content and describe how the content is explored or developed. They provide the language to build in the developmental aspects of the learning of mathematics. The achievement standards reflect the content and encompass the proficiencies.

At this year level:

- **understanding** includes connecting names, numerals and quantities, and partitioning numbers in various ways
- **fluency** includes readily counting number in sequences forwards and backwards, locating numbers on a line and naming the days of the week
- **problem-solving** includes using materials to model authentic problems, giving and receiving directions to unfamiliar places, using familiar counting sequences to solve unfamiliar problems and discussing the reasonableness of the answer
- **reasoning** includes explaining direct and indirect comparisons of length using uniform informal units, justifying representations of data and explaining patterns that have been created.

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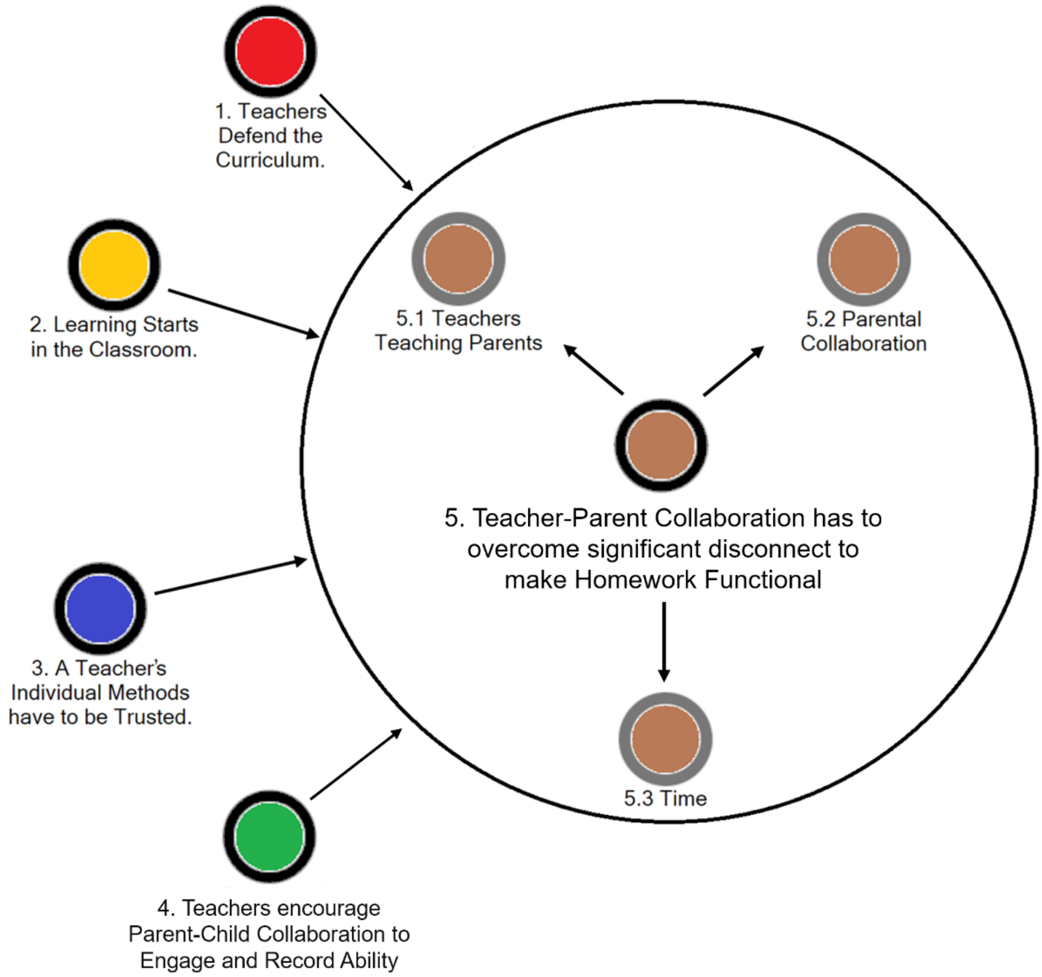
What the Researcher found as universally inherent and self-evident to the Participant Year 1 Teachers from their higher-level and specific training, is that a content description in a pedagogy by way of a learning objective and *measured through to* a learning outcome is an ideal method by which to interface with a curriculum prescription. However, a confusing interchange exists within the Curriculum between the terms learning objective and learning outcome. These terms are used interchangeably within the Curriculum and with no explanation to an outsider or parent. In fact, this type of description may make no sense to a parent in the homework setting. Furthermore, of the many tasks that are expected of primary school teachers, data collection and dissemination is one area that is becoming increasingly stressful to deliver. This is because it can be painstaking for a primary school teacher to assemble this data as a learning outcome that can be easily matched by the parent to the learning objective. This makes it difficult for teachers to communicate an individual child's learning outcomes without context in a succinct way to parents without sounding like jargon at any point during a student's learning journey.

5.3.2 Barriers to Improved Trust between Teacher and Parent

The second demarcated category centres on the requirement of improved trust between teachers and parents. By reviewing and checking if the themes work in relation to the coded extracts and the entire data set, the Researcher perceived a major barrier to adopting any of these features was a poor sense of trust between Teacher and Parent. The Researcher generated 'maps' of the analysis through modelling the code headings to each other – see Figures 21-25. The Researcher's perspective and perception identifies that Themes 1-4 all point to support Theme 5 see Figure 28 whereby teachers teaching parents (5.1), parental collaboration (5.2), and time (5.3) are the key trust issues that need to be resolved to enable teacher-parent collaboration.

Figure 28

Modelling Code Groups and Associated Code Summary Headings.



What became clearer to the Researcher as he moved through each phase of the Reflexive Thematic Analysis process, was the perception of meanings of what each participant Teacher said could be distinguished as effects that pointed towards Teacher-Parent collaboration and the issues that were encapsulated from this. The four required features include:

1. Evidence.
2. Feedback.
3. Easy communication methods.
4. Quantifiable timeframes.

The common issue that binds these features is that of time:

- Better and accurate evidence capture would reduce the *time* needed to examine the evidence.
- Optimal communication would reduce the *time* to provide

meaningful feedback.

- Quantifiable timeframes for homework development by teachers and homework delivery by parents would ease the tension of unknown *time* requirements.

From the Teacher/Participant's perspective, the Researcher perceives that the time taken to develop homework exercises could: hamper activities they could work on that could be substitutes for this time such as sourcing a new book for English; inhibit their time to develop complements for this time such as creating a new math manipulative for class; or impede on their personal free time. What this means is that the greater the amount of time a teacher allocates to developing mathematics homework, the less time they have to develop substitutes for mathematics, complements for mathematics, or for personal free time activities – and vice versa.

The Participants also identified with parents in a similar way given that most of them were parents themselves. They understood that initiating homework competed with parental time constraints that impact on their time to deliver homework exercises. These constraints include: activities they could work on that could be substitutes for this time such as reading a new English book with their child; complements for this time such as playing a math game on a tablet with their child; or personal free time. What this means is that the greater the amount of time a parent allocates to delivering homework, the less time they have for substitute activities, complement activities, or for free time activities – and vice versa.

5.4 Recommendations to Overcome Barriers

The Researcher proposes two recommendations to overcome these barriers. The first is to develop a learning objective schema to interface between the Curriculum and a collaborative homework system. The second proposed recommendation would be to develop a method of improved measurement that quantifies the time it takes for teachers to develop homework and for parents to deliver homework.

5.4.1 Recommendation 1:

Constructing a Learning Objective Interface

The Researcher recommends six steps to develop a functional learning objective interface to enable features 1-8 for a collaborative online homework system to integrate with the Curriculum:

1. Deconstructing the Content Descriptions provided in the Curriculum
2. Reconstructing the Content Descriptions provided in the Curriculum to become learning objectives
3. Defining learning outcomes based on the learning objectives reconstructed from the Content Descriptions provided in the Curriculum
4. Scaffolding learning objectives and learning outcomes within Vygotsky's levels of development
5. Defining a model to tender repetition exercises
6. Defining a model to tender extension exercises

Deconstruction of the Content Descriptions of the Curriculum would enable the construction of quality learning objectives that can then be used to provide meaningful learning outputs. This method would then seamlessly allow scaffolding to be engaged along with variable exercise repetition and appropriate exercise extension.

Step 1: Deconstructing the Content Descriptions provided in the Curriculum

To understand how the first recommendation could be developed the Researcher proposes an example by way of deconstructing the Year 1 Content Descriptions for Mathematics by applying Arreola's (1998) concept of learning objectives reviewed in Section 2.3.1. Table 39 outlines the three Year 1 Content Descriptions (Number and Algebra, Measurement and Geometry, Statistics and Probability) directly from the Curriculum website (see Appendix C, Figure C6 for Content Description of Number and Algebra).

Table 39

Year 1 Content Descriptions for Mathematics.

Year 1 Content Descriptions		
Number and Algebra		
Number and place value		
1	**Develop confidence with number sequences to and from 100 by ones from any starting point. Skip count by twos, fives and tens starting from zero.**	
2	Recognise, model, read, write and order numbers to at least 100. Locate these numbers on a number line.	
3	Count collections to 100 by partitioning numbers using place value.	
4	Represent and solve simple addition and subtraction problems using a range of strategies including counting on, partitioning and rearranging part.	
Fractions and Decimals		
1	**Recognise and describe one-half as one of two equal parts of a whole.**	
Money and financial mathematics		
1	Recognise, describe and order Australian coins according to their value.	
Patterns and algebra		
1	Investigate and describe number patterns formed by skip-counting and patterns with objects.	
Measurement and Geometry		
Using units of measurement		
1	Measure and compare the lengths and capacities of pairs of objects using uniform informal units.	
2	Tell time to the half-hour.	
3	Describe duration using months, weeks, days, and hours.	
Shape		
1	Recognise and describe one-half as one of two equal parts of a whole.	
Location and transformation		
2	Give and follow directions to familiar locations.	

Year 1 Content Descriptions	
Statistics and Probability	
Chance	
1	Identify outcomes of familiar events involving chance and describe them using everyday language such as 'will happen', 'won't happen' or 'might happen'.
2	Tell time to the half-hour.
3	Describe duration using months, weeks, days and hours.
Data representation and interpretation	
1	Choose simple questions and gather responses and make simple inferences.
2	Represent data with objects and drawings where one object or drawing represents one data value. Describe the displays.

Note: Table 39 is an expansion of Appendix C, Figure C6 which is the page at the Australian Curriculum's website for Year 1 Mathematics, https://www.australiancurriculum.edu.au/f-10-curriculum/mathematics

To deconstruct the Content Descriptions provided in the Curriculum to become learning objectives the Researcher directs the reader to look at Table 39 and to the first Content Description (bolded in the table) Number and Place Value within Number and Algebra:

> *Develop confidence with number sequences to and from 100 by ones from any starting point.*
>
> *Skip count by twos, fives and tens starting from zero.*

The problem with the way this Content Description is laid out is that it is impossible to measure against, as it stands, because it contains many expectation variables rolled into two sentences.

Table 40 reviews Arreola's (1998) definition of a learning objective as described in Chapter 2, Section 2.3.1. Arreola's (1998) model has four major components:

1. The condition that outlines the task to be performed by the student.
2. The action criteria for the student's performance.
3. The cognitive behaviour that is required of the student.
4. The standard that determines a positive learning outcome of the learning objective.

Applying this definition to the Content Descriptions in the Curriculum it appears there is no clear condition that outlines the task to be performed by the student; no clear action criteria for the student's performance; no clear cognitive behaviour that is required of the student; and no standard that determines a positive learning outcome.

Table 40

Arreola's (1998) Learning Objective Deconstruction.

Learning Objective	**Condition**	the condition that outlines the task to be performed by the student.
	Action	the action criteria for the student's performance.
	Behaviour	the cognitive behaviour that is required of the student.
	Standard	the standard that determines a positive learning outcome of the learning objective.

In fact, the first sentence in this particular Content Description

> *Develop confidence with number sequences to and from 100 by ones from any starting point*

contains two separate learning objectives. Deconstruction therefore would identify the purpose of the Content Description by breaking it into its constituent parts.

Step 2: Reconstructing the Content Descriptions provided in the Curriculum to become Learning Objectives

Reconstructing this Content Description into defined learning objectives can take place by applying Arreola's (1998) definition. Table 41 shows how the first sentence of this Content Description would look.

Table 41

Learning Objectives for:

Content Description - Develop confidence with number sequences to and from 100 by ones from any starting point.

Learning Objective 1	**Condition**	Given a number between 1 and 100
	Action	a student will be able to
	Behaviour	count
	Standard	forward by ones to 100.

Learning Objective 2	**Condition**	Given a number between 1 and 100
	Action	a student will be able to
	Behaviour	count
	Standard	backward by ones to 1.

Following the reconstruction of this first sentence Table 42 shows how the second sentence of the first Content Description would look with Arreola's (1998) definition of a learning objective applied:

Skip count by twos, fives and tens starting from zero.

Note that this second sentence contains no standard at all in that there is no end point in the skip counting, therefore, the learning objectives in Table 42 would need to be reconstructed with the assumption that 100 is the end counting point as it is in the first sentence.

Table 42

Learning Objectives for:

Content Description - Skip count by twos, fives and tens starting from zero.

Learning Objective 4	**Condition**	Starting at 0
	Action	a student will be able to
	Behaviour	skip count
	Standard	forward by twos to 100.

Learning Objective 5	**Condition**	Starting at 0
	Action	a student will be able to
	Behaviour	skip count
	Standard	forward by fives to 100.

Learning Objective 6	**Condition**	Starting at 0
	Action	a student will be able to
	Behaviour	skip count
	Standard	forward by tens to 100.

Step 3: Defining Learning Outcomes based on the Learning Objectives Reconstructed from the Content Descriptions provided in the Curriculum

A learning outcome is simply the successful address of a learning objective. If the student 'is able to', 'can do', 'can determine' or 'can calculate' then the learning outcome is positively addressed. Fortunately, by applying Arreola's (1998) definition of a learning objective, it is now easy to determine a learning outcome. Table 43 shows the difference between the applied learning objective and learning outcome in bold and italics in the Action criteria of the student's performance.

Table 43

Learning Objectives and Learning Outcomes for:

Content Description - Develop confidence with number sequences to and from 100 by ones from any starting point.

	Learning Objective 1	**Learning Outcome 1**
Condition	Given a number between 1 and 100	Given a number between 1 and 100
Action	a student ***will be able to***	a student ***is able to***
Behaviour	count	count
Standard	forward by ones to 100.	forward by ones to 100.

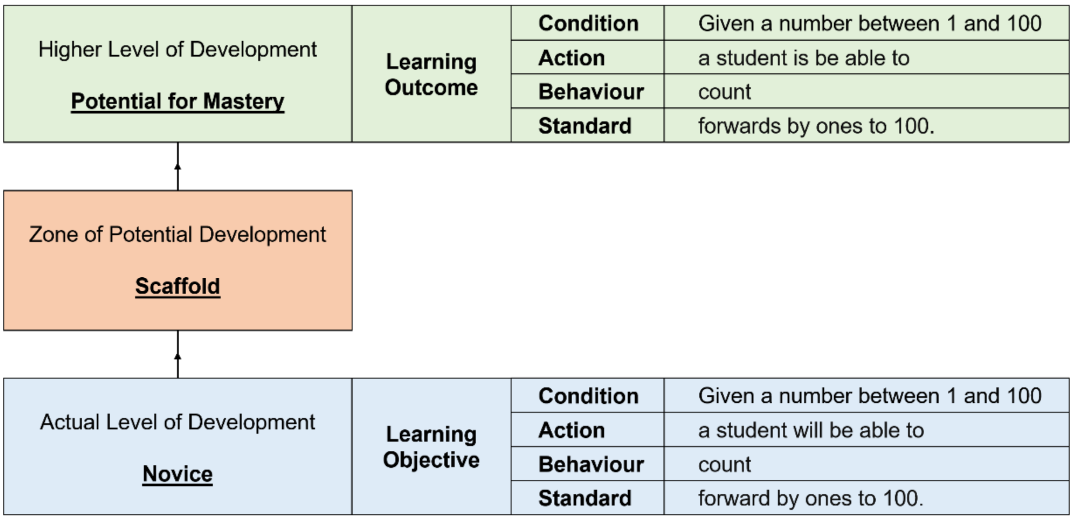
	Learning Objective 2	**Learning Outcome 2**
Condition	Given a number between 1 and 100	Given a number between 1 and 100
Action	a student ***will be able to***	a student ***is able to***
Behaviour	count	count
Standard	forward by ones to 100.	backward by ones to 1.

Step 4: Scaffolding Learning Objectives and Learning Outcomes within Vygotsky's Levels of Development

With clear learning objectives and learning outcomes it is easier to see how Vygotsky's levels of development (see Section 2.2.2) could work and be measured. Figure 29 shows how Arreola's (1998) definition of a learning objective could be applied to the scaffold construct in the Zone of Proximal Development to express a learning outcome.

Figure 29

Learning Objectives and Learning Outcomes Scaffolded in the Zone of Proximal Development.



In Figure 30 the learning objective that is selected by the teacher provides a method for a student to work from their actual level of development through a scaffolded zone of potential development to a measurable learning outcome at their higher level of development. Moreover, we can apply Wood et al.'s (1976) further development of Vygotsky's theories (see Section 2.2.3) through their concept of 'scaffolding' as a method or theory of learning and teaching to show the placement of the learning objective and learning outcome – see Figure 30.

Figure 30

Learning Objectives and Learning Outcomes Graphed and Scaffolded within the Zone of Proximal Development.

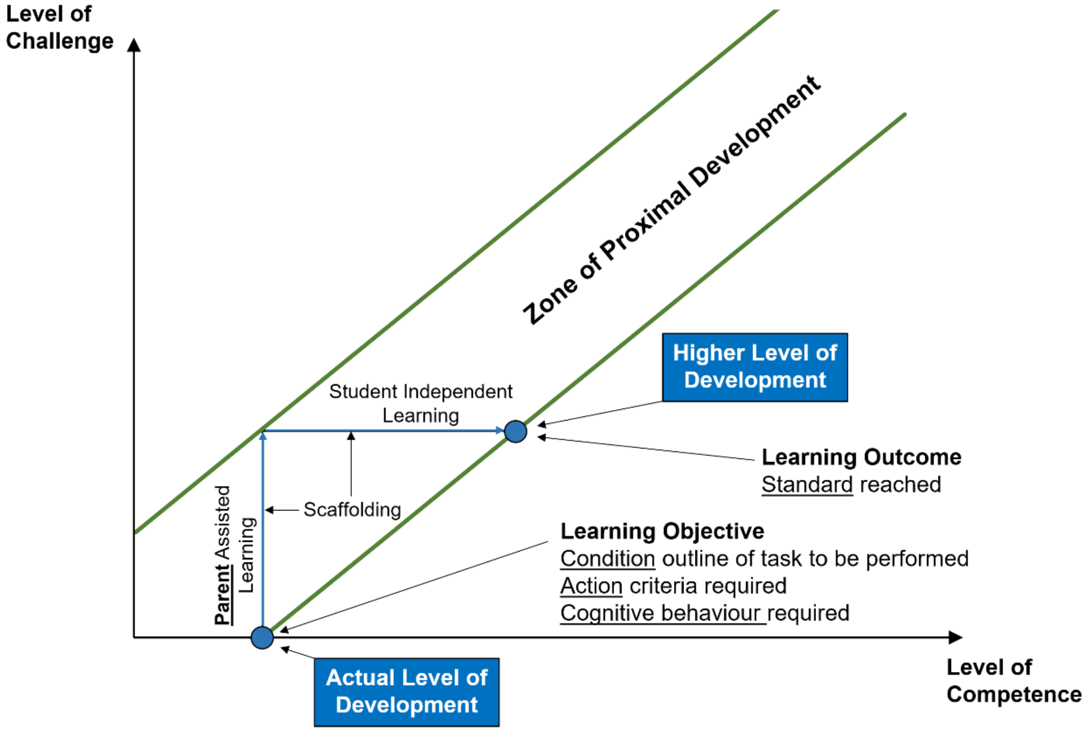


Figure 30 is an application of Figure 10 (Section 2.2.3 Scaffolding) and demonstrates how scaffolding can be applied with parent assistance through increasing the level of challenge from where a new concept is introduced at the Actual Level of Development through the learning objective. The learning objective includes the condition that outlines the task to be performed, the action criteria required, and the cognitive behaviour required. With parent assisted learning, a student's learning is able to be scaffolded through the Zone of Proximal Development to independent learning. Once the concept has been grasped and the required standard is measured, the learning outcome is reached and the student now is at a Higher Level of Development.

For example, a parent might receive instructions from the teacher to introduce the concept of skip counting backwards by twos to a student for the first time and where the teacher is confident that the student's prior knowledge of counting backwards by ones is sufficient to begin. By using some of the techniques identified by Mulvahill (2021), Alber (2011) and

Garelick (2019) above, a parent might use a visual aid such as a number line and start easy at the number 10 followed by front-loading the talk with a definition of the word ‘skip’ as ‘to jump over’ the number 9 and land on the number 8. By pausing and waiting to visually identify that the student ‘gets’ the process, the parent can then ask the student to follow the same process to skip count and see if they can skip the number 7 and land on the number 6. The parent might ask the student to verbalise what is happening. If the student can’t ‘grasp’ the process, the parent can repeat the initial process and wait until the student can follow on correctly. At this point, the vertical accretion of parent assisted learning along the axis of ‘Challenge’, takes place within the ZPD until the learning becomes too challenging for the learner. From there, independent learning increments horizontally along the ‘Competence’ axis until the new concept is grasped by the student. Without a new challenge, the student can become bored with repetition of the grasped concept as it becomes too easy. So, the parent may then see if the student can continue on to the number 4.

A learning objective therefore allows a teacher to select ‘to teach at’ or ‘to teach from’ any part of any of the Curriculum’s Content Descriptions independently of any Curriculum policy coding sequence. The reason why this would be an important condition is that literacy is intertwined with mathematics, and this is where the teacher brings in their expertise, as Mathematics and English Content Descriptions are written separately of each other but are taught together usually to provide context for the student.

So far, this section of the study has demonstrated conceptually how a teacher can move through the Content Descriptions with measurement using scaffolded learning objectives and learning outcomes. Enabling a measurement for a Content Description item provides a way for a teacher to be confident with a student’s mastery to progress along the sequence of understanding provided by the Curriculum’s Content Descriptions. Alternatively, it offers an opportunity for a teacher to diagnose the cognitive stage the student is stuck at, providing evidence for a teacher to offer specific help to encourage a student’s move from novice to mastery within a specific learning objective. This would allow a teacher to optimise their time with a struggling student.

Step 5: Defining a Model to Tender Repetition

Repetitio mater studiorum est is a Latin phrase that has become the cornerstone of maximised learning in cognitive science and is translated as Repetition *is the Mother of all Learning*. However, simply repeating the same exercise in exactly the same way can lead to boredom for students and cognitive slowdown. Therefore, it is imperative that repetition is provided but never the same way. For example, writing learning objectives using different strategies (see Section 2.2) and manipulatives offer a way to do this. Table 44 shows how the second part Fractions and Decimals of the first Content Description would look with Arreola's (1998) definition of a learning objective applied with repetition.

Table 44

Learning Objectives Repeated for:

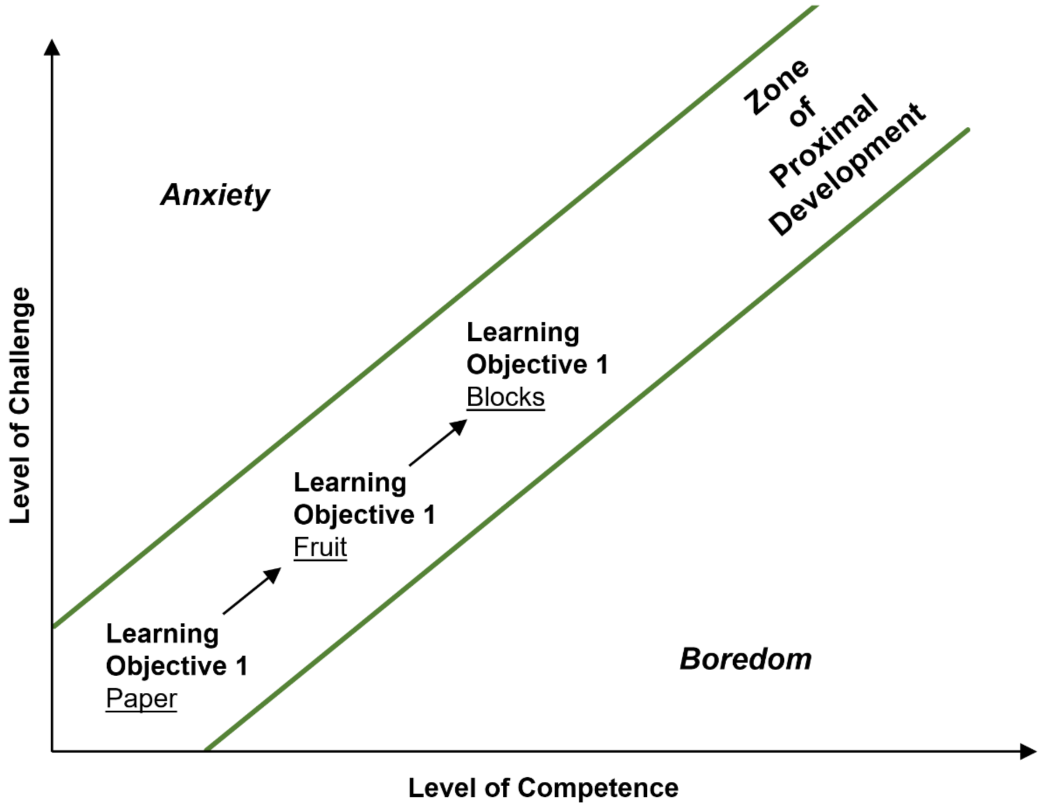
Content Description - Recognise and describe one-half as one of two equal parts of a whole.

	Learning Objective 1 (Paper)	**Learning Objective 1 (Fruit)**
Condition	Given a piece of paper cut in half	Given a piece of fruit cut in half
Action	a student ***will be able to***	a student ***will be able to***
Behaviour	recognise and describe by re-joining	recognise and describe by re-joining
Standard	each half to re-form the whole paper.	each half to re-form the whole fruit.

Figure 31 shows how repetition would look using paper, fruit and blocks as variable manipulatives within the Zone of Proximal Development thus avoiding boredom and anxiety as a student's level of competence grows.

Figure 31

Repetition of Learning Objectives within the Zone of Proximal Development.



Step 6: Defining a Model to Tender Extension Work

It is important to differentiate movement along the sequence of Content Descriptions, as opposed to extending a student's depth within a Content Description. This was a concept clearly adhered to by most Teachers within the transcriptions. A teacher may need to apply progressive difficulty within a Content Description so that the increased level of challenge maintains engagement for those students who have reached mastery of a Content Description early in order to keep the student engaged while the others catch up. This is preferred or else the advanced student can move ahead too quickly and may in fact start learning above their year level. Table 45 shows how a learning objective can be applied to extend the depth for a student within the same Content Description.

Table 45

Learning Objectives and Extension for:

Content Description - Develop confidence with number sequences to and from 100 by ones from any starting point.

	Learning Objective: Number and Place Value	
	Learning Objective	**Extension Learning Objective**
Condition	Given a number between 1 and 100	Given a number between 2 and 200
Action	a student will be able to	a student will be able to
Behaviour	count	count
Standard	forward by ones to 100.	forward by ones to 200.

Limitations to Constructing a Learning Objective Interface

The main limitation to constructing a learning objective interface would be the variable changes that may be made to the Curriculum by ACARA (The Australian Curriculum, Assessment and Reporting Authority). Any change would have to be reflected in the interface and promptly updated. The flow on effect would be to any exercises previously developed being rendered redundant and needing updating.

The other limitation would be the optimal granularity of reconstructed learning objectives. Identifying the optimal level to which learning objectives would need to be reconstructed would need further investigation.

5.4.2 Recommendation 2:
Develop a Method of improved Measurement that Quantifies the Time it takes for Teachers to Develop Homework and for Parents to Deliver Homework

The analysis identified four themes that point to a fifth theme ‘Teacher-Parent Collaboration’ that signals teachers need to overcome significant disconnection with parents to make homework functional. What this means is that improvements for students from implementing features 9-16 into a collaborative homework system hinge on teacher-parent trust. The required features include:

1. Evidence.
2. Feedback.

3. Easy communication methods.
4. Quantifiable timeframes.

To improve the trust between teachers and parents, the Researcher recommends the use of common templates that can be used to develop homework exercises. Common templates would communicate consistency to parents between exercises. This recommendation of common templates includes following a framework that is based on the construction of a learning objective interface (see Recommendation 1 above), such as Arreola’s (1998) model, which has four major components: the condition that outlines the task to be performed by the student; the action criteria for the student’s performance; the cognitive behaviour that is required of the student; and the standard that determines a positive learning outcome of the learning objective.

Adopting such a method improved trust between teachers and parents and could be further improved through the inclusion of an exercise time requirement that quantifies the time it takes for teachers to develop homework and parents to deliver homework. Furthermore, by including a digital communication mechanism built into the template, a teacher can provide a meaningful feedback system between members using appropriate evidentiary methods. This would significantly reduce the time constraints of both teachers and parents for developing homework and delivering homework.

Limitations to Developing Time Quantifiable Homework Exercises

The main limitation for developing time quantifiable homework exercises would be identifying what quantifiable timeframes would be optimal. Optimal time quantification may be different based largely on cultural and socioeconomic factors. This is because different parts of Australia or even different schools (for example independent schools and state schools) may harbour differing views on the time allocation for teachers to develop homework exercises and for students to spend at home completing the homework exercises. This means that identification of a teacher-parent time budget for homework would need to be investigated to enable a quantifiable time for parents to read simple instructions and identify the time requirement for homework exercises. Therefore, further investigation of what quantifiable timeframes would be optimal would be required.

5.5 Existing Applications

The Researcher identified applications provided in the Curriculum and applications used by the Participants. None of these applications connect directly to any learning objective of the Curriculum or provide any interface to connect to the Curriculum. Without clearly defined learning objectives, any existing applications provided in the Curriculum or applications used by the Participants would have difficulty being adapted to produce meaningful learning outcomes. Furthermore, none of the applications reviewed provided any meaningful allocation of time that would be expected of a parent to deliver the exercises in the applications.

5.5.1 Applications Provided in the Curriculum

An in-depth review of the Year 1 maths digital learning technologies in the Curriculum was undertaken by the Researcher and this review is in Appendix D. This review shows that the resources provided in the Curriculum are detached from any purposed learning objective and lack any interface to the Content Descriptions of the Curriculum. Appendix D summarises all of the digital ‘resources’ including apps, Flash apps, images, and websites available to teachers (and parents) on the Australian mathematics Curriculum website for Year 1. Table 46 lists the codes used in the Curriculum to identify the 98 resources within each of the content descriptions: number and algebra (56); measurement and geometry (24); and statistics and probability (18).

Table 46

Australian Mathematics Curriculum Content Year 1.

Content Description		
Number and Algebra	**Code**	**Total Resources: 56**
	ACMNA012	12
	ACMNA013	9
	ACMNA014	7
	ACMNA015	11
	ACMNA016	1
	ACMNA017	9
	ACMNA018	7
Measurement and Geometry	**Code**	**Total Resources: 24**
	ACMMG019	4
	ACMMG020	6
	ACMMG021	5
	ACMMG022	4
	ACMMG023	5
Statistics and Probability	**Code**	**Total Resources: 18**
	ACMSP024	1
	ACMSP262	4
	ACMSP263	13

The resources provided in the Curriculum under these codes are not demarcated as either a teacher resource or a parent resource and this could present confusion for parents. From the analysis none of these resources were identified as being used by any of the Participant/Teachers. The Researcher contends that this may due, in large part, to the construction of those resources in that none contain a clear learning objective that scaffolds the student to a viable learning outcome that matches to the Achievement Standards of the Curriculum. Furthermore, teacher training to use these tools as well as their perceived self-efficacy in using the tools will also likely be factors that any further study should consider. A statistically significant study of a much larger sample of teachers (and parents) across Australia could help quantify whether this is a common trait and indicative longitudinally.

5.5.2 Applications used by Participants

The transcriptions of each interview were searched to identify existing applications used by Teachers in-class (see Table 47) and applications used as homework apps (see Table 48). From the understanding of the literature review (Chapter 2) and Reflexive Thematic Analysis (Chapter 3), no consistently developed collaborative online homework solution is currently available for Australian Year 1 mathematics. Furthermore, none of the applications used by the Participant Teachers have any way of interfacing with the Curriculum.

Table 47

Applications used by participants In-Class.

Classroom Apps										
	School	**01**		**02**		**03**		**04**		
	Participant	**0101**	**0102**	**0201**	**0202**	**0301**	**0302**	**0401**	**0402**	
Classroom App	Seesaw					5	8			**Teacher Usage**
	Math-U-See	3	1							
	ClassDojo			1	1	1				
	Zoom		2				1			
	Blackboard	1								
	BrainPop Junior	1								
	Hit the Button						1			
	ictGames		1							
	Loom	1								
	MS Publisher	1								
	RoleM Maths		1							

Table 48

Applications used by Participants for Homework.

Homework Apps										
	School	**01**		**02**		**03**		**04**		
	Participant	**0101**	**0102**	**0201**	**0202**	**0301**	**0302**	**0401**	**0402**	
Homework App	Email BCC	4	5		1					**Teacher Usage**
	Mathletics			1	4		2			
	School Website	4	2				1			
	Studyladder	2	2							
	Google Classroom	1				1	2			
	Google Slide	4								
	ictGames		3							
	Khan Academy	1	1							
	SmashMaths			2						
	Google Suite	1								
	Sunshine Online					1				
	PDF	1								

Tables 47 and 48 represent the number of times a particular app was mentioned and by which participant. Only one app (ictGames) was used as both a classroom app and a homework app. Participants 0101 and 0102 at School 01 tended to be the biggest users of apps of both types. The Participant/Teachers all identified the use of any of the apps as ‘supportive’ in class and/or home environments. None of the Participant/Teachers identified the use of any of these apps as essential to their teaching. Both tables show in tabularised form that no Teacher in the interviews identified the use of any of the content on the Curriculum website and no comprehensive or common use of any software application for use in classroom or as a homework tool. The Researcher proposes that this sporadic and inconsistent usage may be due to the fact that many of these apps are developed by overseas development companies made to fit as many country/territory users as possible. What this means is that they are made to be ‘general’ supportive educational resources and not ‘specific’ solutions for the Australian Year 1 Mathematics Curriculum.

5.6 Limitations

Throughout this study, the Researcher identified limitations to the research: finding prior research and data on the topic; finding a participant sample; participant group size; access to participants; inclusion/exclusion of participants; constructing a learning objective interface; and developing time quantifiable homework exercises. However, the research was particularly limited by the lack of recent prior research and finding available measurement data specifically around the research question.

5.6.1 Limitations to Finding Prior Research and Data on the Topic

The literature review reported on the relationship between the teacher, parent, student cohort; educational theories for application development; educational theories and constructs for application measurement; and learning technologies. Within these categories, no study explored what is understood about collaborative online learning with a view to identifying the features necessary to design a collaborative online mathematics homework system that supports a partnership between Year 1 teachers, parents, and students. Given the rapid advance in online technologies within the last two decades, the Researcher considers that technologies have either not caught up with the needs of this cohort, or that technology companies see more viable opportunities for profit elsewhere in the education community.

5.6.2 Limitations to Finding a Participant Sample

Appendix G outlines the problems and issues that arose within the backdrop of the COVID19 pandemic to identify potential schools to approach in Queensland. This includes: the reasoning for choosing Independent Schools in Queensland; how the Researcher approached independent schools through personal contacts and emails direct to their school principals; and how the Researcher approached teachers directly through Facebook groups.

5.6.3 Limitation of Participant Group Size

While the participant group size used in this study is within the acceptable range of Braun and Clarke's (2021) Reflexive Thematic Analysis, a larger sample including participants from state schools and remote schools could have provided more insights and new understandings established through ongoing data engagement or from studying the data from many different points of view.

5.6.4 Logistical Limitations - Access to Participants

The COVID-19 pandemic caused most of the logistical limitations and access restrictions to conducting this study because they were in-person paired depth interviews. While all interviews were offered through Zoom video if in-person interviews could not take place, it became apparent that the richness of in-person interviews were far superior. Furthermore, from a quantitative perspective, the small sample size was a potential limitation to knowing exactly what can be designed on a larger scale.

5.6.5 Limitations – Inclusion/Exclusion of Participants

The constraints of inclusion or exclusion of participants also limited the scope of this study. These constraints included the teacher participants having a range of experience in teaching; all were current primary school teachers; all having had at least five years teaching at primary school; and all having taught Year 1 within the last three years. These constraints were imposed so that the more recent the participants' experience of Year 1 mathematics, the closer the data would be to reality, given the rate of change of technology. These constraints narrowed the sample size considerably, whereas a fuller data set could be achieved with some of these constraints relaxed.

5.6.6 Limitations to Constructing a Learning Objective Interface

The main limitation to constructing a learning objective interface would be the variable changes that may be made to the Curriculum by ACARA (The Australian Curriculum, Assessment and Reporting Authority). Any change would have to be reflected in the interface and promptly updated. The flow on effect would be to any exercises previously developed being rendered redundant and needing updating. The other limitation would be the optimal granularity of reconstructed learning objectives. Identifying the optimal level to which learning objectives would need to be reconstructed would need further investigation.

5.6.7 Limitations to Developing Time Quantifiable Homework Exercises

The main limitation for developing time quantifiable homework exercises is identifying what quantifiable timeframes would be optimal. Optimal time quantification may be different based largely on cultural and socioeconomic factors. This is because different parts of Australia, or even different schools (for example independent schools and state schools), may harbour differing views on the time allocation for teachers to develop homework exercises and for students to spend at home completing the homework exercises. This means that identification of a teacher-parent time budget for homework would need to be investigated to enable a quantifiable time for parents to read simple instructions and identify the time requirement for homework exercises. Therefore, further investigation of what quantifiable timeframes would be optimal would be required.

5.7 Conclusion

The opening chapter of this study introduced mathematics as: beautiful; important for cognitive development; a provider of great job opportunities; helpful in everyday life; help to Australia to perform better economically; and a backbone for technological advancement.

Chapter 2 reviewed the literature regarding; the relationship between teacher, parent, and student; educational theories for application development; educational theories for application measurement; and system design and development. This chapter culminated with the research question.

Chapter 3 outlined the methodology and research design adopted for this study by the Researcher including: the epistemological viewpoint; pragmatic paradigm; a preview of the way the data was analysed through Braun and Clarke’s Reflexive Thematic Analysis; determining and justifying the participant group and group size; participant inclusion/exclusion criteria;

an exposé of paired depth interviews; ethical limitations; the interview questions; and the intended outputs of the data analysis.

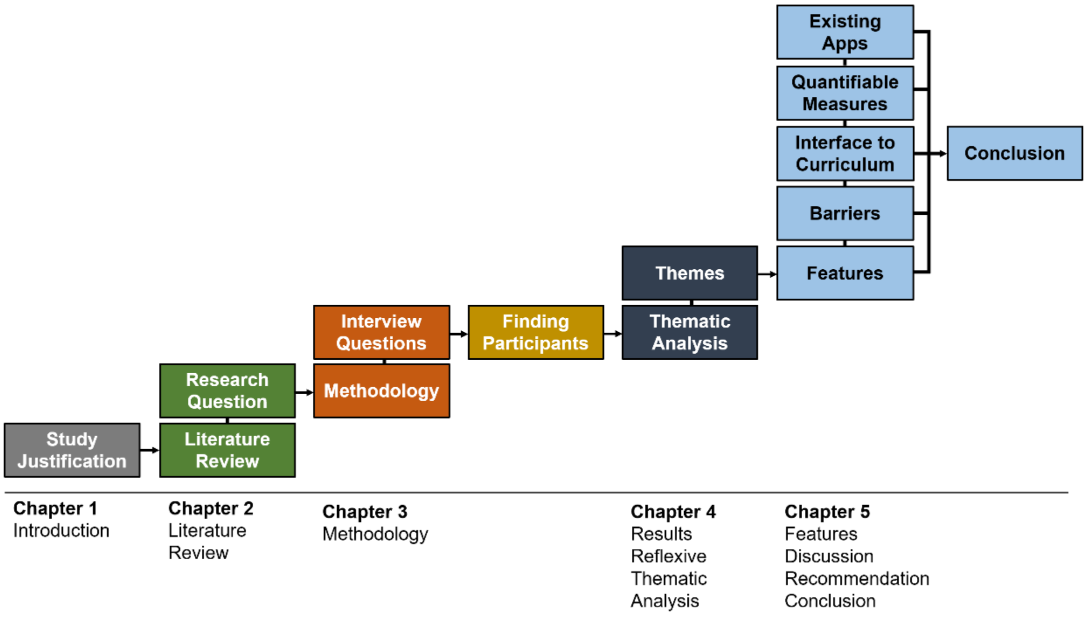
Chapter 4 presented a step-by-step application of Braun and Clarke's Reflexive Thematic Analysis: data familiarisation; systematic data coding; generating initial themes from coded and collated data; developing and reviewing themes; and refining, defining, and naming themes.

Chapter 5 positioned the themes associated to the research question and the features from the Participant/Teacher's perspective; identified the barriers to developing the features into a collaborative online homework system; provided recommendations to overcome those barriers and limitations to developing those recommendations; identified the existing applications provided in the Curriculum and those used by the Participants to review whether any provide the required features; and limitations of the research.

Figure 32 shows the progress of this study chapter by chapter.

Figure 32

Chapter by Chapter Progress.



This study has identified that the Australian Mathematics Curriculum tells a teacher 'what' to teach without any stated method of objective that can be simply communicated to parents for homework exercises. It provides no coded learning objectives, and the criteria for parents to know where their child sits academically is not specific and quite vague. This creates an interpretive dilemma for teachers if they are to extend a student within these boundaries and not extend them into the next year's level. Further, the term 'level' is used in the Curriculum ambiguously. This has created a maelstrom of 'jargon' that provides no clear guidance or measurement for a parent to determine whether homework has direction, has value, and whether one teacher is better at developing homework than another. Furthermore, the Curriculum provides no evidentiary method for teachers to use to backtrack and prove a child's level of understanding. This function is solely reliant on the teacher – and at great burden to them.

This study opines a unique opportunity to use homework and parental utility as a means to make homework more functional within the Content Description framework of the Curriculum. The outcome of this would allow students to show creativity in their solutions, to allow them to expand their knowledge, and to provide evidence for teachers. A successful online collaborative homework system will require features that improve student outcomes within fixed easily identifiable time constraints for development and delivery so that teachers and parents know upfront what is reasonably expected of them, so that they both trust each other's position for the improvement of their student/child's development. The required features of a collaborative online homework system defined in terms of the themes identified from the analysis with the research question would therefore need to:

1. Conduit the Curriculum for teachers' needs but operate in the background for parents.
2. Differentially and dynamically branch from the classroom learning through a private network to each home and to formatively inform back to the teacher.
3. Adjunct a teacher's knowledge, differentially assigning students to ability groups, formatively recording and feeding back to students and their parents.
4. Digitally store evidentiary proof of a student's hands-on manipulative homework contribution.

5. Restore trust by empowering parents with time quantifiable consumable tasks that set up manipulative exercises that can measure a student's ability and inherently promote homework functionality.

Figure 33 applies the IPO (Input-Process-Output) model (see Figure 14, Section 2.4.2) to show how the required features for a collaborative online homework system for Year 1 mathematics would operate. The IPO model initiates with inputs, works through processes, and produces outputs. Control mechanisms usually embed within the process, and outcomes of the output would feedback information to potentially modify inputs or processes for the system to cycle. The recommended learning objective interface would be part of the control mechanism and the recommendations for improved trust would be part of the feedback mechanism.

Figure 33

Input-Process–Output Model Applied.

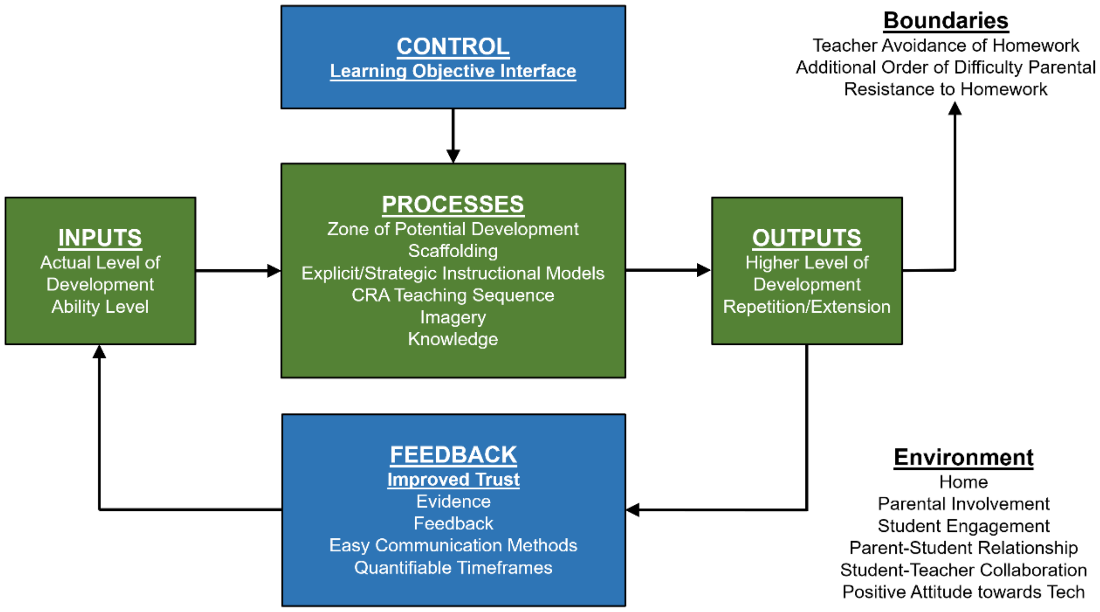


Figure 33 shows the Researcher's current thinking about how this system would function and how it will foster collaboration through a sequence initiated by the teacher who chooses homework learning objectives for the ability groups of their class (Inputs). The use of automatic notifications would direct students and parents to work asynchronously measuring students in their actual level of development, scaffolding through the zone of potential development (Processes), controlled through a learning objective interface (Control), and working towards a higher level of development and possibly moving up to a higher ability group through uploading photo or video evidence in the processes (Outputs). This evidence could then be easily and quickly reviewed by the teacher who can author or else select from a bank of pre-written comments to provide feedback (Feedback). Automatic notifications are presumed to be similar to the digital methods currently utilised through modern smartphone applications. A paradigm shift would invariably need to take place for widespread adoption to overcome many of the boundaries or objections that sit currently with the concept of homework such as teacher/school avoidance of homework, additional order of difficulty for teachers, and parental reluctance to homework (Boundaries).

This study has reviewed a range of issues identified within the eyes of the Curriculum, the literature, and most importantly the teachers who shoulder the burden of teaching. The analysis of these issues has identified the features necessary to develop a collaborative online homework system for Year 1 mathematics (see Table 49) demarcated by the recommendations for a learning objective interface and measures for improved trust between teacher and parent.

Table 49

The Required Features for a Collaborative Online Homework System for Year 1 Mathematics.

		Features
Learning Objective Interface	**1**	Teachers can identify learning objectives that are defined and matched to the Curriculum.
	2	Teachers can select learning objectives from a database to deliver as homework exercises.
	3	Teachers can match learning objectives to an individual student based on their ability.
	4	Teachers can select extensions to the learning objectives based on an individual student's ability.
	5	Teachers can select from a variety of strategic methods to form repetition to learning objectives.
	6	Teachers can select learning objectives to apply concrete/manipulative, representational, or abstract methods.
	7	Teachers can feedback to students about their progress from their actual level of development to higher levels of development through learning outcome statements.
	8	Teachers can verify learning outcome statements from actual level of development to a higher level of development.

		Features
Improved Teacher/ Parent Trust	**9**	Teachers can see video evidence of a student's progression.
	10	Teachers can feedback to students and parents to encourage movement through ability groups.
	11	Teachers can quickly identify learning objectives' wording so that students can work independently from parental input.
	12	Teachers can access easy communication methods for Parents to assist homework activities.
	13	Teachers can identify quantifiable timeframes for homework exercise development.
	14	Teachers can easily communicate timeframes for homework delivery by parents.
	15	Teachers can choose pre-selected or user-defined feedback to provide to parents in context.
	16	Teachers can receive pre-selected or user-defined feedback from parents.

This research Masters study needs to validly inform further research and be the key link to provide a map of the thematic understanding of teachers concerns around this phenomenon. Because the onus lies with teachers to instantiate homework, the power to administer homework sits proportionally with teachers. This study therefore needed to identify why teachers see homework as important (or not), what their frustrations are, and why collaboration could be good. This foundation, along with educational principles, would be a necessary component to develop the software specification, software resource plan, and underlying design.

A further study would therefore need to determine a subset picture of which cultures within the Australian society view homework positively and work with those that show more receptivity to it and where it leads to more success. A lead-by-example approach would inevitably be the most pragmatic way forward. The exact technical solutions are out of scope of this study and could be considered in a later study.

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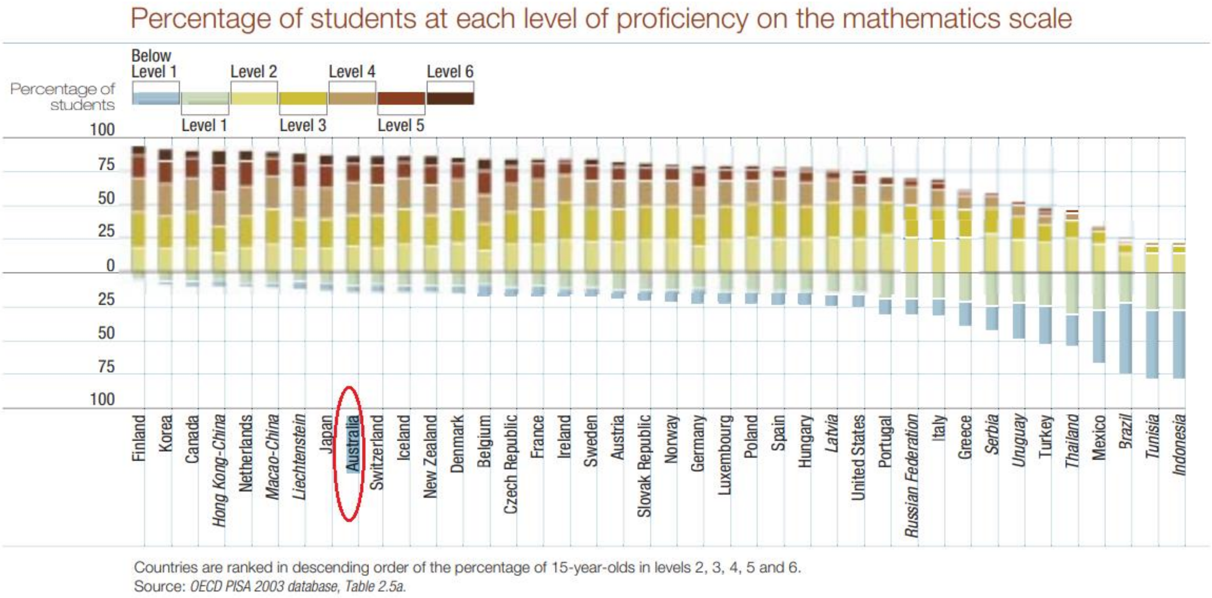
Appendix A

Programme for International Student Assessment 2003

The Figures in this Appendix are from the OECD Programme for International Student Assessment (OECD PISA) 2003 which is the product of a collaboration between participating governments through the OECD (Organisation for Economic Co-operation and Development).

Figure A1

Percentage of Students at Each Level of Proficiency on the Mathematics Scale



Note. Figure A1 classifies 15-year-olds in each country according to the highest level of mathematical proficiency that they demonstrated in the 2003 OECD PISA assessments. From *OECD PISA* (2003), p. 8.

Figure A2

Student Proficiency in Mathematics (2003)

Student proficiency in mathematics

Summary descriptions for the six levels of proficiency in mathematics

Score points	Level	What students can typically do
668	Level 6	At Level 6 students can conceptualise, generalise, and utilise information based on their investigations and modelling of complex problem situations. They can link different information sources and representations and flexibly translate among them. Students at this level are capable of advanced mathematical thinking and reasoning. These students can apply insight and understanding along with a mastery of symbolic and formal mathematical operations and relationships to develop new approaches and strategies for dealing with novel situations. Students at this level can formulate and precisely communicate their actions and reflections regarding their findings, interpretations, arguments and the appropriateness of these to the original situations.
606	Level 5	At Level 5 students can develop and work with models for complex situations, identifying constraints and specifying assumptions. They can select, compare, and evaluate appropriate problem-solving strategies for dealing with complex problems related to these models. Students at this level can work strategically using broad, well-developed thinking and reasoning skills, appropriately linked representations, symbolic and formal characterisations, and insight pertaining to these situations. They can reflect on their actions and formulate and communicate their interpretations and reasoning.
544	Level 4	At Level 4 students can work effectively with explicit models for complex concrete situations that may involve constraints or call for making assumptions. They can select and integrate different representations, including symbolic ones, linking them directly to aspects of real-world situations. Students at this level can utilise well-developed skills and reason flexibly, with some insight, in these contexts. They can construct and communicate explanations and arguments based on their interpretations, arguments and actions.
482	Level 3	At Level 3 students can execute clearly described procedures, including those that require sequential decisions. They can select and apply simple problem-solving strategies. Students at this level can interpret and use representations based on different information sources and reason directly from them. They can develop short communications reporting their interpretations, results and reasoning.
420	Level 2	At Level 2 students can interpret and recognise situations in contexts that require no more than direct inference. They can extract relevant information from a single source and make use of a single representational mode. Students at this level can employ basic algorithms, formulae, procedures, or conventions. They are capable of direct reasoning and making literal interpretations of the results.
358	Level 1	At Level 1 students can answer questions involving familiar contexts where all relevant information is present and the questions are clearly defined. They are able to identify information and to carry out routine procedures according to direct instructions in explicit situations. They can perform actions that are obvious and follow immediately from the given stimuli.

Note. Figure A2 describes the proficiency levels from 1 to 6 of what students can typically do in mathematics. From *OECD PISA (2003)*, p. 5.

Appendix B

Programme for International Student Assessment 2018

The charts in this Appendix are from the OECD Programme for International Student Assessment (PISA) 2018 which is the product of a collaboration between participating governments through the OECD (Organisation for Economic Co-operation and Development).

Figure B1

Snapshot of Performance in Reading, Mathematics and Science (2018)

Snapshot of performance in reading, mathematics and science

- (blue) Countries/economies with a mean performance/share of **top performers above** the OECD average; Countries/economies with a share of **low achievers below** the OECD average
- (white) Countries/economies with a mean performance/share of top performers/share of low achievers **not significantly different** from the OECD average
- (grey) Countries/economies with a mean performance/share of **top performers below** the OECD average; Countries/economies with a share of **low achievers above** the OECD average

OECD	Mean score in PISA 2018			Long-term trend: Average rate of change in performance, per three-year-period			Short-term change in performance (PISA 2015 to PISA 2018)			Top-performing and low-achieving students	
	Reading	Mathematics	Science	Reading	Mathematics	Science	Reading	Mathematics	Science	Share of top performers in at least one subject (Level 5 or 6)	Share of low achievers in all three subjects (below Level 2)
	Mean	Mean	Mean	Score dif.	Score dif.	Score dif.	Score dif.	Score dif.	Score dif.	%	%
OECD average	487	489	489	0	-1	-2	-3	2	-2	15.7	13.4
Estonia	523	523	530	**6**	**2**	0	4	4	-4	22.5	4.2
Canada	520	512	518	-2	**-4**	**-3**	-7	-4	**-10**	24.1	6.4
Finland	520	507	522	**-5**	**-9**	**-11**	-6	-4	**-9**	21.0	7.0
Ireland	518	500	496	0	0	**-3**	-3	-4	-6	15.4	7.5
Korea	514	526	519	**-3**	**-4**	**-3**	-3	2	3	26.6	7.5
Poland	512	516	511	**5**	**5**	2	6	**11**	**10**	21.2	6.7
Sweden	506	502	499	**-3**	-2	-1	6	8	6	19.4	10.5
New Zealand	506	494	508	**-4**	**-7**	**-6**	-4	-1	-5	20.2	10.9
United States	505	478	502	0	-1	2	8	9	6	17.1	12.6
United Kingdom	504	502	505	2	1	-2	6	**9**	-5	19.4	9.0
Japan	504	527	529	1	0	-1	**-12**	-5	**-9**	23.3	6.4
Australia	503	491	503	**-4**	**-7**	**-7**	0	-3	**-7**	18.9	11.2
Denmark	501	509	493	1	-1	0	1	-2	**-9**	15.8	8.1
Norway	499	501	490	1	2	1	**-14**	-1	**-8**	17.8	11.3
Germany	498	500	503	**3**	0	**-4**	-11	-6	-6	19.1	12.8
Slovenia	495	509	507	2	2	**-2**	**-10**	-1	**-6**	17.3	8.0
Belgium	493	508	499	-2	**-4**	**-3**	-6	1	-3	19.4	12.5
France	493	495	493	0	**-3**	-1	-7	2	-2	15.9	12.5
Portugal	492	492	492	**4**	**6**	**4**	-6	1	**-9**	15.2	12.6
Czech Republic	490	499	497	0	**-4**	**-4**	3	7	4	16.6	10.5
Netherlands	485	519	503	**-4**	**-4**	**-6**	**-18**	7	-5	21.8	10.8
Austria	484	499	490	-1	-2	**-6**	0	2	-5	15.7	13.5
Switzerland	484	515	495	-1	**-2**	**-4**	-8	-6	**-10**	19.8	10.7
Latvia	479	496	487	2	2	-1	**-9**	**14**	-3	11.3	9.2
Italy	476	487	468	0	**5**	-2	-8	-3	**-13**	12.1	13.8
Hungary	476	481	481	-1	**-3**	**-7**	6	4	4	11.3	15.5
Lithuania	476	481	482	2	-1	**-3**	3	3	7	11.1	13.9
Iceland	474	495	475	**-4**	**-5**	**-5**	-8	**7**	2	13.5	13.7
Israel	470	463	462	**6**	**6**	3	-9	-7	-4	15.2	22.1
Luxembourg	470	483	477	-1	-2	-2	**-11**	-2	**-6**	14.4	17.4
Turkey	466	454	468	2	**4**	**6**	**37**	**33**	**43**	6.6	17.1
Slovak Republic	458	486	464	**-3**	**-4**	**-8**	5	**11**	3	12.8	16.9
Greece	457	451	452	-2	0	**-6**	-10	-2	-3	6.2	19.9
Chile	452	417	444	**7**	1	1	-6	-5	-3	3.5	23.5
Mexico	420	409	419	2	**3**	2	-3	1	3	1.1	35.0
Colombia	412	391	413	**7**	**5**	**6**	**-13**	1	-2	1.5	39.9
Spain	m	481	483	m	0	-1	m	-4	**-10**	m	m

Notes: Values that are statistically significant are marked in bold (see Annex A3).
Long-term trends are reported for the longest available period since PISA 2000 for reading, PISA 2003 for mathematics and PISA 2006 for science.
Results based on reading performance are reported as missing for Spain (see Annex A9). The OECD average does not include Spain in these cases.
Countries and economies are ranked in descending order of the mean reading score in PISA 2018.
Source: OECD, PISA 2018 Database, Tables I.B1.10, I.B1.11, I.B1.12, I.B1.26 and I.B1.27.
StatLink https://doi.org/10.1787/888934028140

Note. Figure 1 highlights a snapshot of Australia's 2018 mathematical performance as not significantly different from the OECD average. From *OECD PISA* (2018b), pg. 17, (Table I.1).

Appendix C

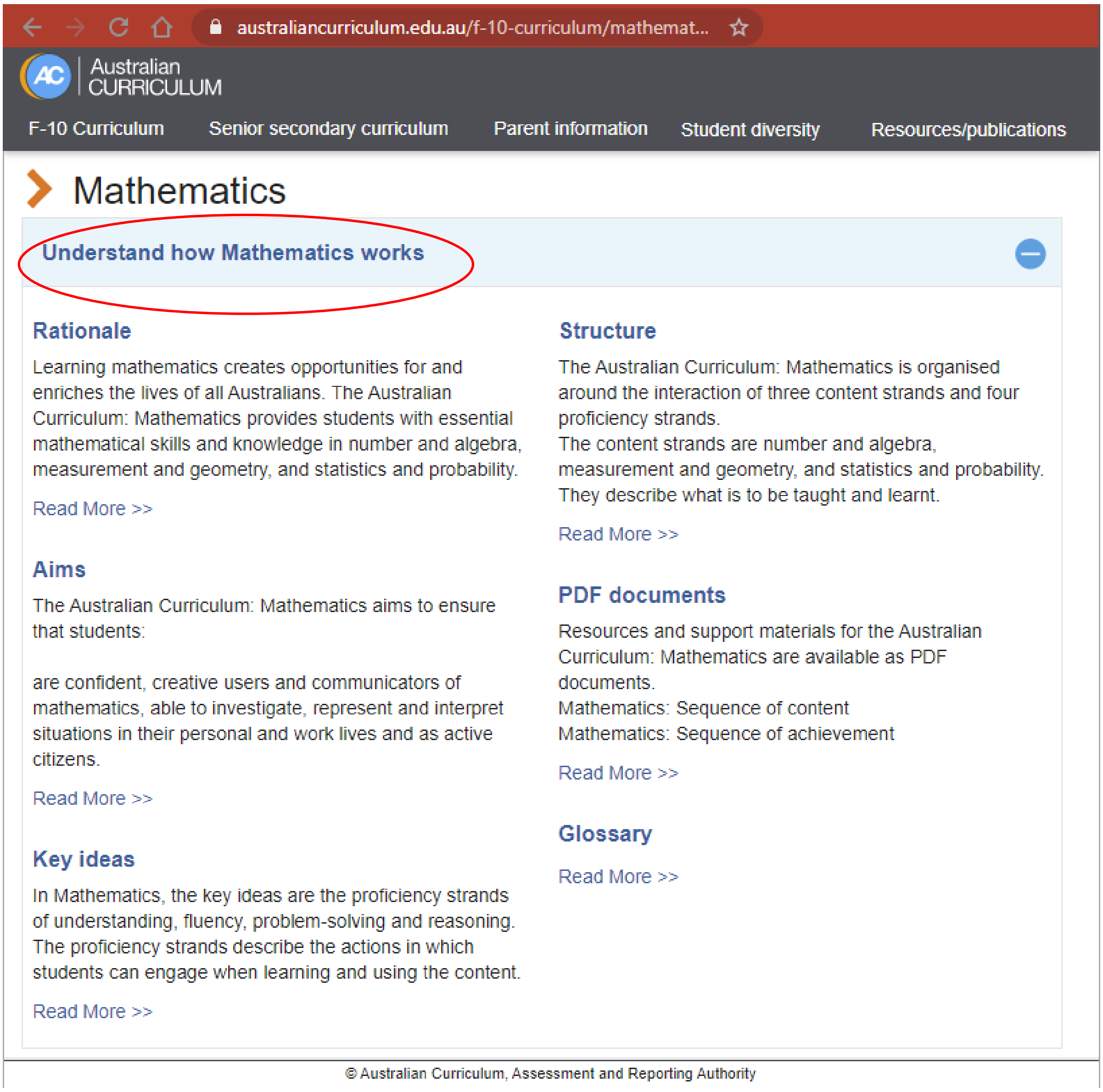
Australian Mathematics Curriculum Website

The screenshots in this Appendix are from the publicly accessible website of:

- Australian Mathematics Curriculum (October 2021). https://www.australiancurriculum.edu.au

Figure C1

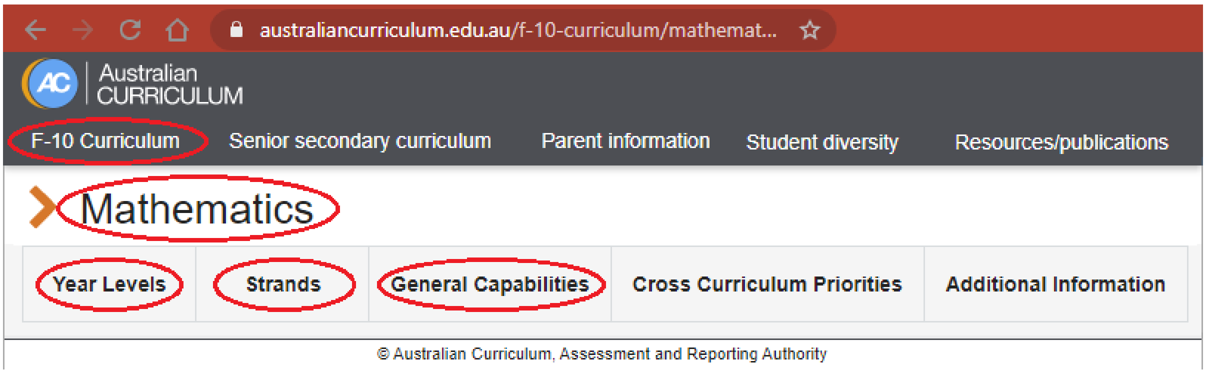
Understanding how Mathematics Works in the Australian Mathematics Curriculum



Note. Figure C1 shows the main screen and a description of how mathematics works in the Australian Curriculum website. From Australian Curriculum, 2021 (www.australiancurriculum.edu.au/f-10-curriculum/mathematics).

Figure C2

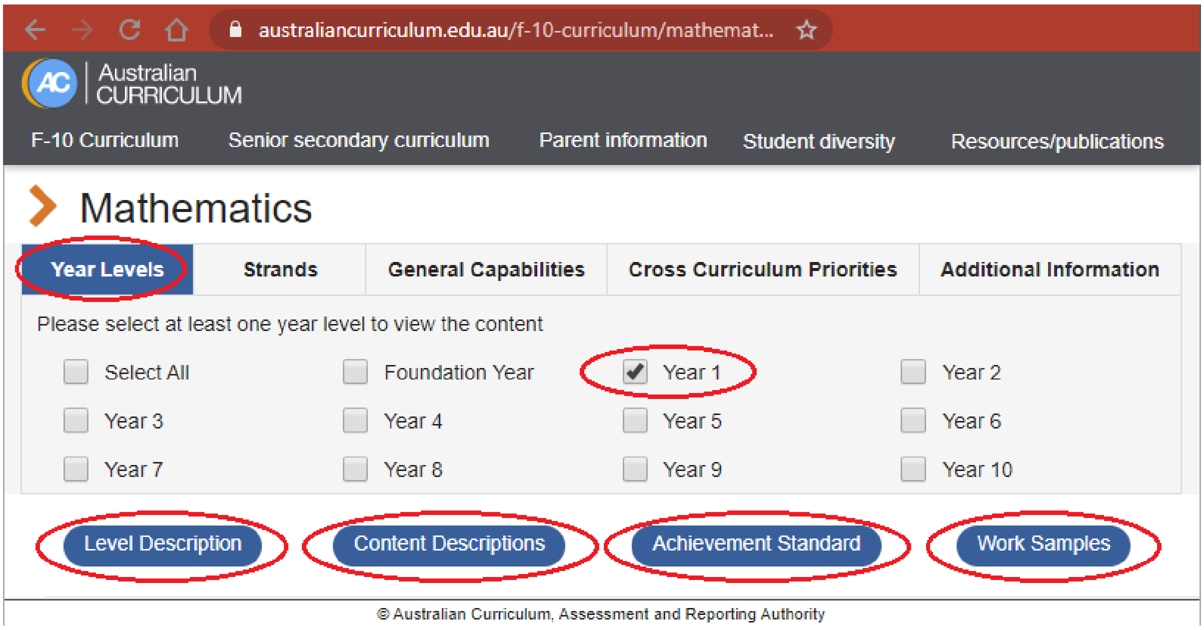
The Australian Mathematics Curriculum



Note. Figure C2 shows that by selecting ‘Mathematics’ in the ‘F-10 Curriculum’ heading three main sub-headings become available – ‘Year Levels’, ‘Strands’, ‘General Capabilities’ – that are links to expansions that show more detail. From Australian Curriculum, 2021 (www.australiancurriculum.edu.au/f-10-curriculum/mathematics). © 2013 Australian Curriculum, Assessment and Reporting Authority, all rights reserved.

Figure C3

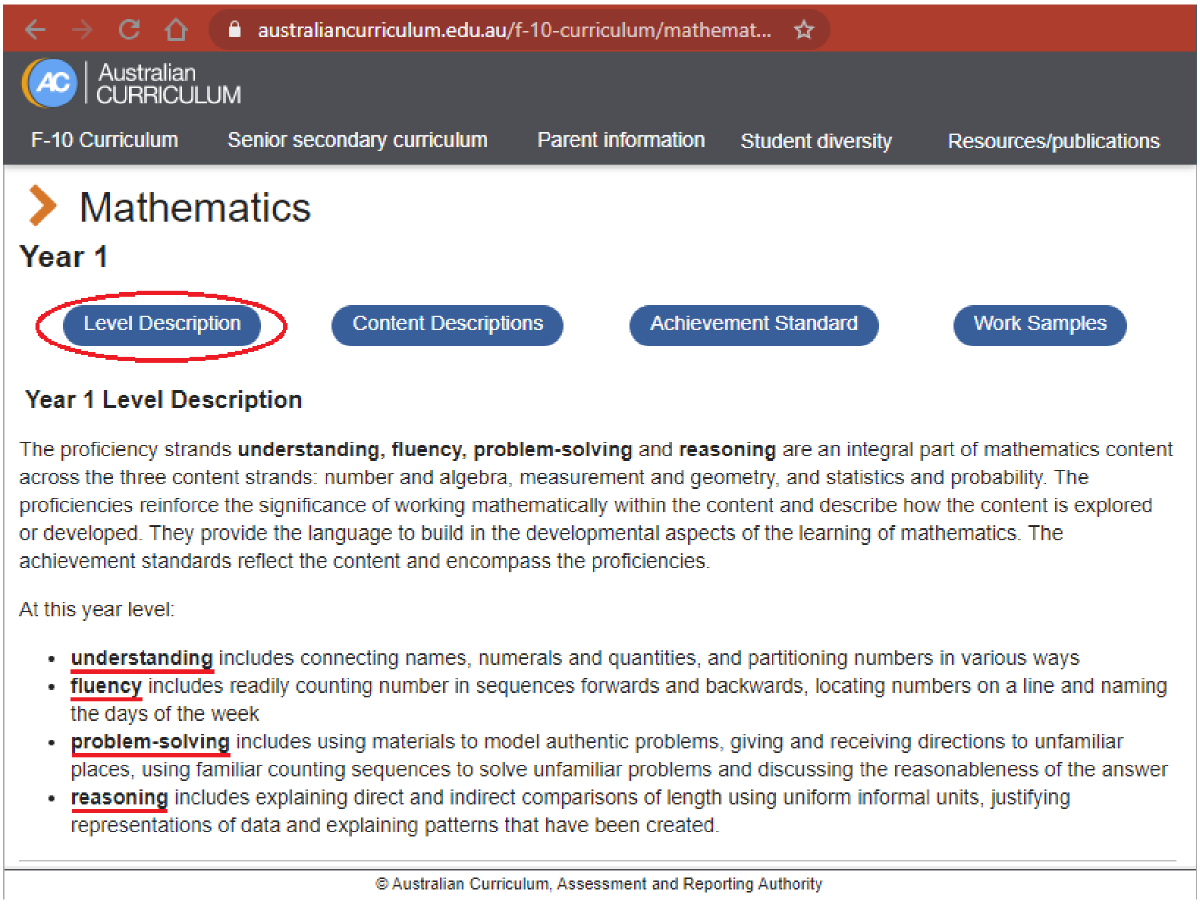
Year 1 in the Australian Mathematics Curriculum



Note. Figure C3 shows the results of selecting Year 1 – ‘Level Description’, ‘Content Description’, ‘Achievement Standards’, ‘Work Sample Portfolios’. From Australian Curriculum, 2021 (www.australiancurriculum.edu.au/f-10-curriculum/mathematics). © 2013 Australian Curriculum, Assessment and Reporting Authority, all rights reserved.

Figure C4

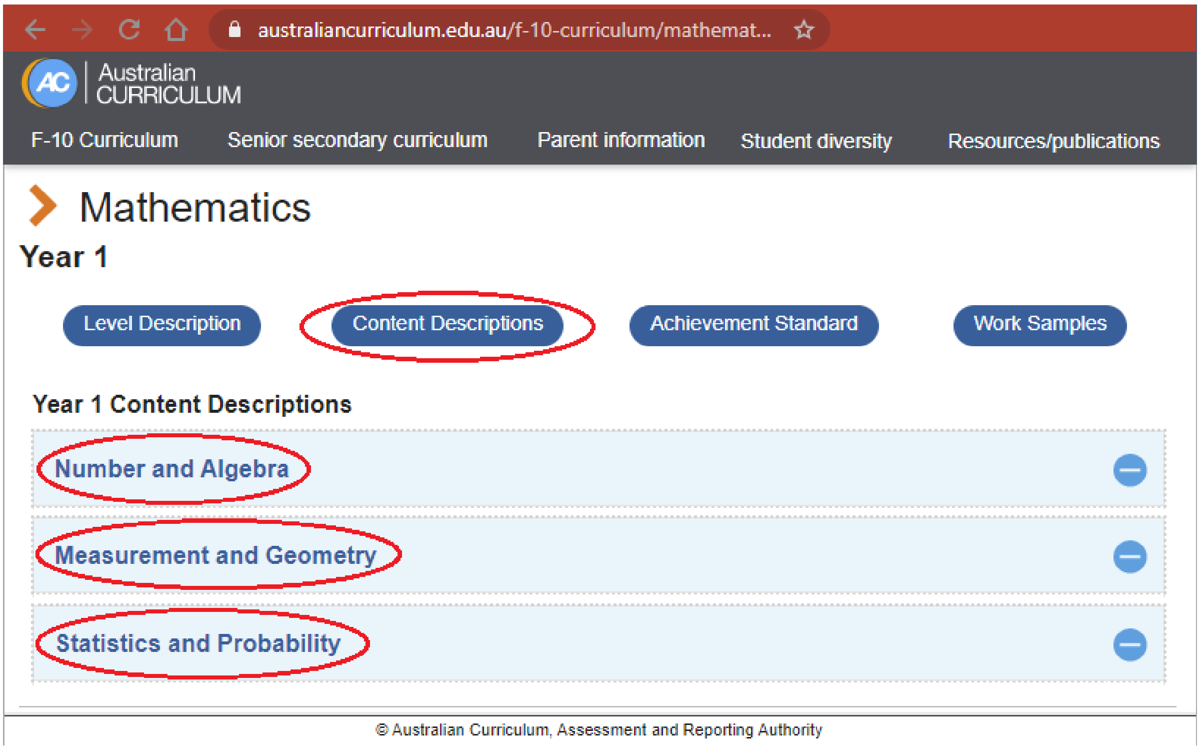
Year 1 Level Description in the Australian Mathematics Curriculum



Note. Figure C4 identifies the details for Year 1 ‘Level Description’ that identifies the proficiency strands ‘understanding’, ‘fluency’, ‘problem-solving’ and ‘reasoning’. From Australian Curriculum, 2021 (www.australiancurriculum.edu.au/f-10-curriculum/mathematics).

Figure C5

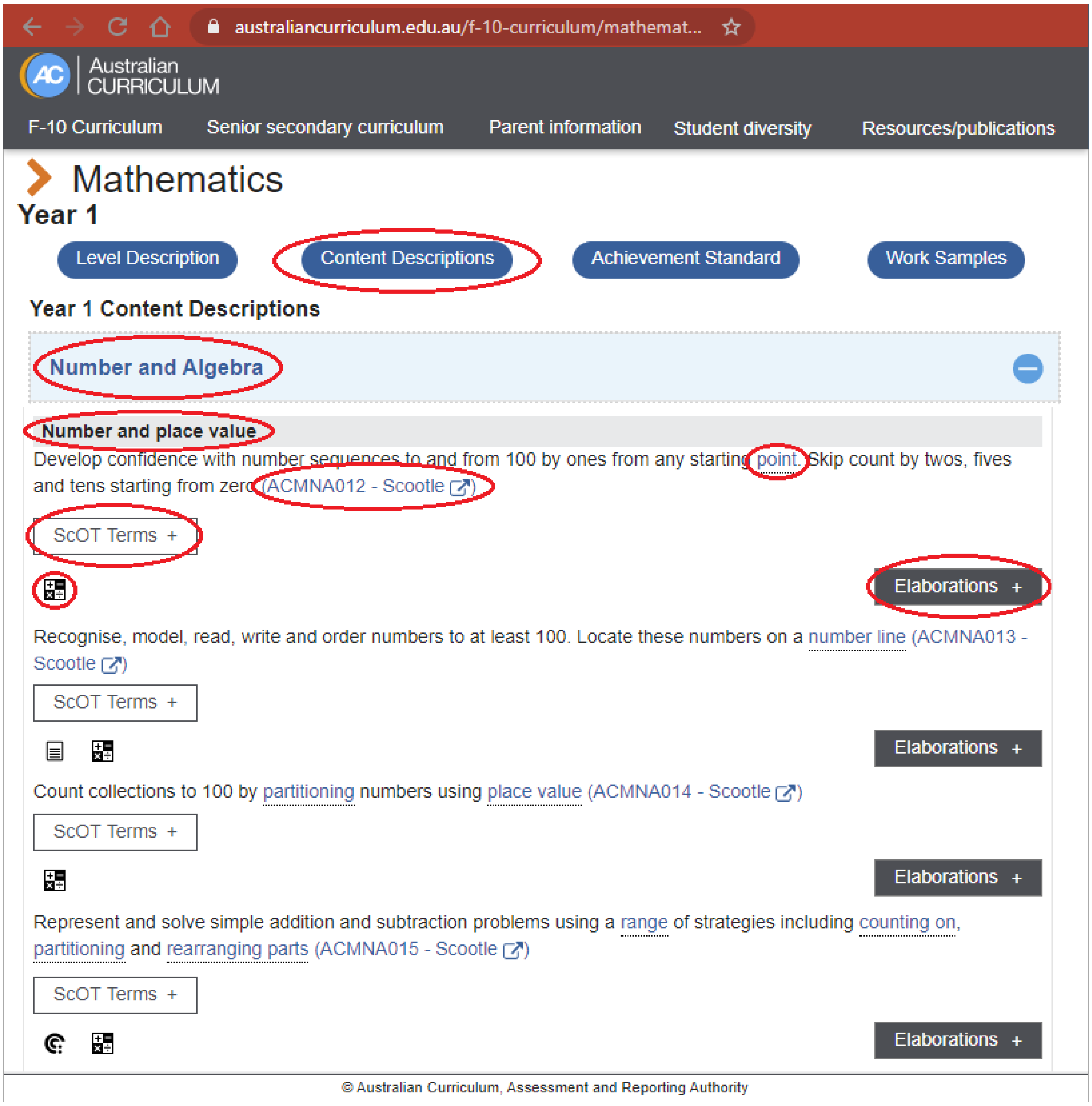
Year 1 Content Descriptions in the Australian Mathematics Curriculum



Note. Figure C5 shows that by clicking the 'Content Descriptions' button that access to the Year 1 content descriptions of 'Number and Algebra', 'Measurement and Geometry' and 'Statistics and Probability' become available. From Australian Curriculum, 2021 (www.australiancurriculum.edu.au/f-10-curriculum/mathematics). © 2013 Australian Curriculum, Assessment and Reporting Authority, all rights reserved.

Figure C6

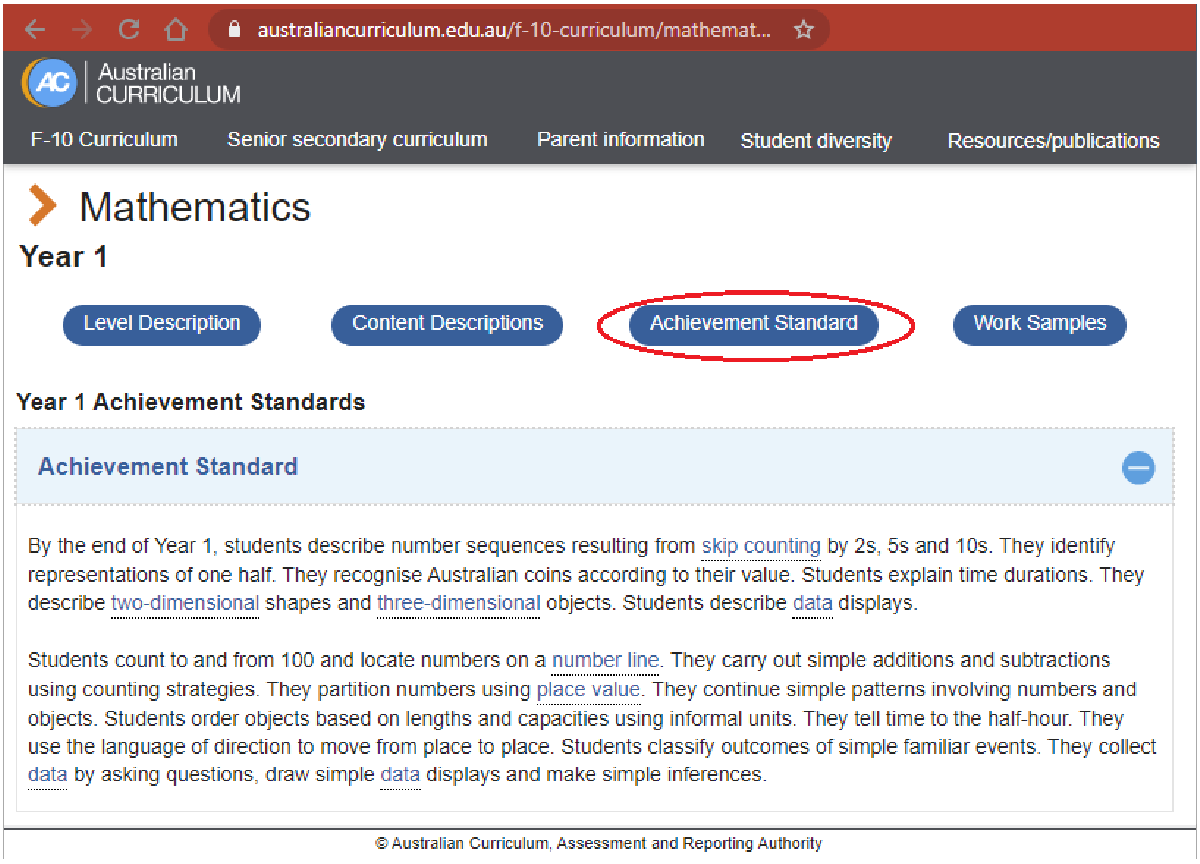
Year 1 Content Descriptions Number and Algebra in the Australian Mathematics Curriculum



Note. Figure C6 shows the expansion of the 'Number and Algebra' button. This shows a selection of information including 'Scootle codes', 'ScOT Terms', 'Elaborations' and rollover definitions. From Australian Curriculum, 2021 (www.australiancurriculum.edu.au/f-10-curriculum/mathematics). © 2013 Australian Curriculum, Assessment and Reporting Authority, all rights reserved.

Figure C7

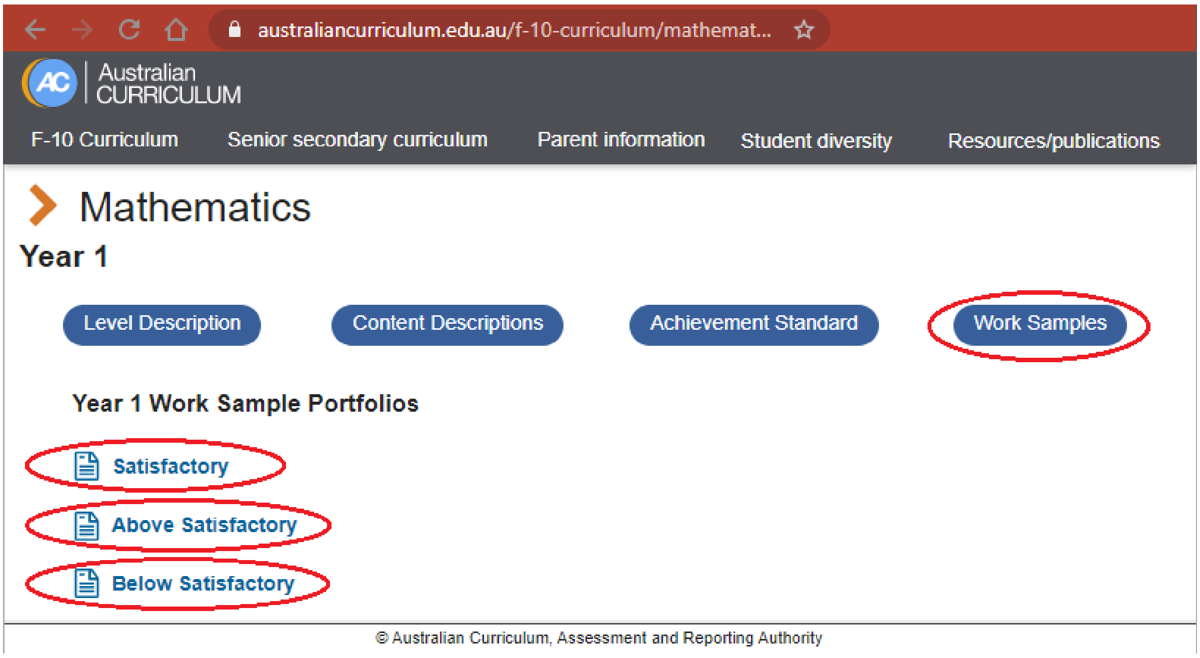
Year 1 Achievement Standards in the Australian Mathematics Curriculum



Note. Figure C7 shows the 'Achievement Standards' for Year 1 Mathematics. From Australian Curriculum, 2021 (www.australiancurriculum.edu.au/f-10-curriculum/mathematics). © 2013 Australian Curriculum, Assessment and Reporting Authority, all rights reserved.

Figure C8

Year 1 Work Samples in the Australian Mathematics Curriculum



Note. Figure C8 shows access points to 'Work Samples'. These are grouped in 'Satisfactory', 'Above Satisfactory' and 'Below Satisfactory' sections. From Australian Curriculum, 2021 (www.australiancurriculum.edu.au/f-10-curriculum/mathematics). © 2013 Australian Curriculum, Assessment and Reporting Authority, all rights reserved.

Appendix D

A Review of Year 1 Maths Digital Learning Technologies Provided in the Curriculum

Introduction

The Curriculum interweaves a complex structure that is impervious to untrained teachers through the linkage of year levels, strands, general capabilities, understanding, level description, content description, Scootle content codes, ScOT terms, elaborations, and achievement standards (see Appendix C, Figures C1-C8), with little guidance on the ‘gauge’ of measurement through ‘proficiency’ and ‘performance’. The Australian Curriculum provides a range of online digital content for parents for Year 1 mathematics and this Appendix describes and defines this content through a criterion based on the full spectrum of the properties of the content items. This includes a range of content, types, and their development history some of which date from as early as 1978. Some of these types are images and videos while others require more interactivity with the student.

D.1 Learning Technologies aligned with the Australian Curriculum

Tables D1-D4 provide a technical criterion with definitions of the acronyms and abbreviations used in the Curriculum website, indexing over twenty-five variables that could make up any resource. These variables have been grouped under four headings: resource, technology, content, and learning.

D.1.1 Resource

Table D1 shows the content technical criteria for the resource variable of the content resources in the Curriculum.

Table D1

Australian Mathematics Curriculum Content Technical Criteria - Resource

Resource		
Teacher Resource		✓ ✗
Publisher/Author	**AAS**	Australian Academy of Science
	ABC	Australian Broadcasting Corporation
	AEF	Asia Education Foundation
	ASIC	Australian Securities and Investments Commission
	CADRE	CADRE Design
	clarity	Clarity Innovations
	CWA	CWA New Media
	echalk	e-chalk UK
	ESA	Education Services Australia
	MLC	Math Learning Centre
	NAS	National Academy of Science
	NSWDE	State of NSW\, Department of Education
	RAMINT	Royal Australian Mint
	skwirk	Swirk Online Education
	TLF	The Learning Federation
	UTAS	University of Tasmania
	2and2	2and2
	CSIRO	CSIRO Publishing
Date Created		Year

Under the resource heading the first variable identified is whether the resource is a teacher resource to help a teacher in their job or a learning resource designed to help a student learn. The next variable attempts to classify who the publisher/author is. Not all resources provide a clear path to identify the original author, or the first publisher, or whether the resource had been created under an umbrella organisation. For example, The Learning Federation (TLF) was listed numerous times for content items created by various content creators over 20 years ago as an initiative of the state, territory and federal governments of Australia and New Zealand. In January 2001, the Prime Minister of Australia announced, as part of the ‘Backing Australia’s Ability’ package, $34.1 million over five years to:

> “…develop a body of high-quality curriculum content, suitable for each State and Territory, develop a framework that supports

> distributed access, and over the long term, use the framework and content to stimulate further contribution to the pool of material."

This initiative was project managed by Curriculum Corporation (The Learning Federation, 2009). The Curriculum Corporation was since taken over by Education Services Australia (ESA) and TLF resources are now delivered through a national digital repository portal called 'Scootle'. The date created is the last variable under this heading and was also difficult to ascertain with many of the resources using the date that they were acquired and published by ESA and delivered through Scootle.

D.1.2 Technology

Table D2 shows the content technical criteria for the technology variable of the content resources in the Curriculum.

Table D2

Australian Mathematics Curriculum Content Technical Criteria - Technology

Technology		
Type	**Flash**	Software for content created on the Adobe Flash platform (discontinued)
	HTML	HyperText Markup Language is code in a file to display on the Internet.
	PDF	Portable Document Format - file extension for printable documents.
	PPT	PowerPoint - .ppt is a file extension for Microsoft presentation file format.
	Video	Video files embedded in HTML pages.
	iOS	Internet Operating System developed by Apple for its hardware.
	Android	Android mobile operating system for Linux based touchscreen devices.
Data Storage	**Local**	Local data storage saving data to media connected to computing device.
	Online	Online data storage involves virtual storage of data in a remote network.
Login Required		Username and Password is required for access.
Pre-load		Content provides a pre-load part of the content to allow user access.
Loading Speed		How long it takes an item to load before it starts.
Duration		The duration of an item.
Audio		The content has audio.

To identify the technology each resource had to be viewed in full as some of the types of technology had been modified to fit the Scootle portal. For example, Flash items had been modified into video or PDF format. Also, some items had been created for open operating systems such as HTML or closed operating systems such as Apple’s iOS or Google’s Android. In addition, cataloguing included whether the resource stored data online or offline, whether there was a login required, whether there was a built-in pre-load, what the loading speed was, what the duration was and whether there was audio.

D.1.3 Content

Table D3 shows the content technical criteria for the content variable of the content resources in the Curriculum.

Table D3

Australian Mathematics Curriculum Content Technical Criteria - Content

Content	
Manipulatives	The content item requires manipulatives.
Abstract	The content item does not depend on real world objects
Symbols	The content item uses symbols.
Numerals	The content item uses numerals
Number Words	The content item uses number words.
Integrated to other Content	The content is integrated to other content.

The content and learning headings largely identify variables linked to the educational theories identified in the literature review. Under the content heading characteristics specific to mathematics were searched for such as whether the resource required or used manipulatives, abstractness, mathematical symbols, mathematical numerals, number words and whether they were integrated to other content.

D.1.4 Learning

Table D4 shows the content technical criteria for the learning variable of the content resources in the Curriculum.

Table D4

Australian Mathematics Curriculum Content Technical Criteria - Learning

Learning	
Instructions for Students	Clear instructions are provided to students.
Instructions for Parents	Clear instructions are provided to parents.
Learning Objective	Learning Objectives provided that relate to those set by the Curriculum.
Learning Outcome	Learning Outcomes provided that relate to those set by the Curriculum.
Feedback to Students	Students receive Feedback
Progress Display	A student’s progress is displayed as the content item is accessed.
Agility Measurement	Measurement of agility is displayed as the content item is accessed.
Ability Levels	A student’s ability level is displayed as the content item is accessed.
Proficiency Measurement	Measurement of proficiency is displayed as content item is accessed.

The learning heading catalogues whether any of the educational theories or measurement had been captured by the resource such as instructions for parents, instructions for students, whether there was a clear learning objective directed from the Curriculum, whether there was a clear learning outcome directed from the Curriculum, whether there was clear feedback to students, whether there was progress display for a student, whether there was any measurement of the student’s agility either during or after using the resource, whether there was any indication that identified to the student or parent the ability level of the student and where they sit in class, and whether was any visible measurement of the student’s proficiency.

D.2 Australian Mathematics Curriculum Content

Table D5 lists the codes used in the Curriculum to identify groups of content items within each of the content descriptions: number and algebra; measurement and geometry; and statistics and probability.

Table D5

Australian Mathematics Curriculum Content Year 1

Content Description	
Number and Algebra	**Code**
	ACMNA012
	ACMNA013
	ACMNA014
	ACMNA015
	ACMNA016
	ACMNA017
	ACMNA018
Measurement and Geometry	**Code**
	ACMMG019
	ACMMG020
	ACMMG021
	ACMMG022
	ACMMG023
Statistics and Probability	**Code**
	ACMSP024
	ACMSP262
	ACMSP263

Note: The Acronym codes ACMNA, ACMMG, and ACMSP are not explicitly defined in the Australian Curriculum but stand for:

ACMNA: Australian Curriculum Maths Numeracy and Algebra

ACMMG: Australian Curriculum Maths Measuring and Geometry

ACMSP: Australian Curriculum Maths Statistics and Probability

D.2.1 Number and Algebra: Code ACMNA012

Table D6 provides a detailed review of the resources under Code ACMNA012 available on the Curriculum website under the resource heading. Table D7 provides a detailed review of the resources under Code ACMNA012 available on the Curriculum website under the technology heading. Table D8 provides a detailed review of the resources under Code ACMNA012 available on the Curriculum website under the content heading. Table D9 provides a detailed review of the resources under Code ACMNA012 available on the Curriculum website under the learning heading.

Table D6

Resources for ACMNA012 within Content Description Number and Algebra for Year 1.

Content Description Code ID	Title	Resource: Teacher Resource	Resource: Publisher Author	Resource: Date Created
Number and Algebra				
ACMNA012				
TLF-ID L1063	Musical number patterns: musical counter		ESA	2013
TLF-ID L2317	Number Trains		ESA	2016
TLF-ID L2320	Number trains: numbers 30–50		ESA	2013
TLF-ID L2322	Skip Counting		ESA	2014
TLF-ID L8275	Number Trains: Patterns: Assessment		ESA	2011
TLF-ID L8276	Number Trains: Counting On: Assessment		ESA	2011
TLF-ID M013994	Numbers and counting - Foundation	✓	AEF	2013
TLF-ID M013995	Counting games - years 1 and 2	✓	AEF	2012
TLF-ID M016278	Sites2See – number for primary	✓	NSWDE	2018
TLF-ID M017866	MoneySmart: Bertie's socks	✓	ASIC	2017
TLF-ID M021824	reSolve: Skip Counting: How Many Birds?	✓	NAS	2018
TLF-ID M024877	reSolve: Authentic Problems: Grandma's Soup	✓	NAS	2019

Table D7

Technology for ACMNA012 within Content Description Number and Algebra for Year 1

Content Description Code ID	Title	Technology: Type	Data Storage	Login Req	Pre-load	Loading Speed	Duration	Audio
Number and Algebra								
ACMNA012								
TLF-ID L1063	Musical number patterns: musical counter	Flash	Local	×	×	0s	10m	×
TLF-ID L2317	Number Trains	HTML	×	×	×	25s	10m	✓
TLF-ID L2320	Number trains: numbers 30–50	Flash	Local	×	✓	2s	10m	✓
TLF-ID L2322	Skip Counting	Flash	Local	×	✓	2s	10m	✓
TLF-ID L8275	Number Trains: Patterns: Assessment	Flash	Local	×	✓	2s	10m	✓
TLF-ID L8276	Number Trains: Counting On: Assessment	Flash	Local	×	✓	2s	10m	✓
TLF-ID M013994	Numbers and counting - Foundation	HTML	×					
TLF-ID M013995	Counting games - years 1 and 2	HTML	×					
TLF-ID M016278	Sites2See – number for primary	HTML	×					
TLF-ID M017866	MoneySmart: Bertie's socks	PDF	×					
TLF-ID M021824	reSolve: Skip Counting: How Many Birds?	PDF/PPT	×					
TLF-ID M024877	reSolve: Authentic Problems: Grandma's Soup	PDF/PPT	×					

Table D8

Content for ACMNA012 within Content Description Number and Algebra for Year 1

Content Description Code ID	Title	Manipu-latives	Abstract	Manipulatives /Abstract Mix	Symbols	Numerals	Number Words	Integrated to Other Content
Number and Algebra								
ACMNA012								
TLF-ID L1063	Musical number patterns: musical counter	×	×	✓	×	✓	×	×
TLF-ID L2317	Number Trains	×	×	✓	×	✓	×	×
TLF-ID L2320	Number trains: numbers 30–50	×	×	✓	✓	✓	✓	×
TLF-ID L2322	Skip Counting	×	×	✓	✓	✓	✓	×
TLF-ID L8275	Number Trains: Patterns: Assessment	×	×	✓	✓	✓	✓	×
TLF-ID L8276	Number Trains: Counting On: Assessment	×	×	✓	✓	✓	✓	×
TLF-ID M013994	Numbers and counting - Foundation							
TLF-ID M013995	Counting games - years 1 and 2							
TLF-ID M016278	Sites2See – number for primary							
TLF-ID M017866	MoneySmart: Bertie's socks							
TLF-ID M021824	reSolve: Skip Counting: How Many Birds?							
TLF-ID M024877	reSolve: Authentic Problems: Grandma's Soup							

Table D9

Learning for ACMNA012 within Content Description Number and Algebra for Year 1

Content Description Code ID	Title	Instructions for Student	Instructions for Parent	Learning Objective	Learning Outcome	Feedback to Students	Progress Display	Agility Measurement	Ability Levels	Proficiency Measurement
Number and Algebra										
ACMNA012										
TLF-ID L1063	Musical number patterns: musical counter	×	×	×	×	at end	×	×	×	×
TLF-ID L2317	Number Trains	✓	×	×	×	at end	×	×	×	×
TLF-ID L2320	Number trains: numbers 30–50	✓	×	×	×	at end	×	×	×	×
TLF-ID L2322	Skip Counting	✓	×	×	×	at end	×	×	×	×
TLF-ID L8275	Number Trains: Patterns: Assessment	✓	×	×	×	at end	×	×	×	×
TLF-ID L8276	Number Trains: Counting On: Assessment	✓	×	×	×	at end	×	×	×	×
TLF-ID M013994	Numbers and counting - Foundation									
TLF-ID M013995	Counting games - years 1 and 2									
TLF-ID M016278	Sites2See – number for primary									
TLF-ID M017866	MoneySmart: Bertie's socks									
TLF-ID M021824	reSolve: Skip Counting: How Many Birds?									
TLF-ID M024877	reSolve: Authentic Problems: Grandma's Soup									

D.2.2 Number and Algebra: Code ACMNA013

Table D10 provides a detailed review of the resources under Code ACMNA013 available on the Curriculum website under the resource heading. Table D11 provides a detailed review of the resources under Code ACMNA013 available on the Curriculum website under the technology heading. Table D12 provides a detailed review of the resources under Code ACMNA013 available on the Curriculum website under the content heading. Table D13 provides a detailed review of the resources under Code ACMNA013 available on the Curriculum website under the learning heading.

Table D10

Resources for ACMNA013 within Content Description Number and Algebra for Year 1.

Content Description Code ID	Title	Resource: Teacher Resource	Resource: Publisher Author	Resource: Date Created
Number and Algebra				
ACMNA013				
TLF-ID L2002	Scale matters: simple units		CWA	2013
TLF-ID L2003	Scale matters: ones		CWA	2013
TLF-ID L2004	Scale matters: tens		CWA	2013
TLF-ID L2321	Number trains: numbers 90–120		ESA	2013
TLF-ID M015939	Recording numbers		ABC	1999
TLF-ID M017879	MoneySmart: needs and wants		ASIC	2014
TLF-ID M019626	Number line, by the Math Learning Centre		MLC	2015
TLF-ID M021822	reSolve: Place Value: Number Sorting		ESA	2018
TLF-ID M024880	reSolve: Authentic Problems: Target Ball		NAS	2018

Table D11

Technology for ACMNA013 within Content Description Number and Algebra for Year 1.

Content Description Code ID	Title	Technology: Type	Data Storage	Login Req	Pre-load	Loading Speed	Duration	Audio
Number and Algebra								
ACMNA013								
TLF-ID L2002	Scale matters: simple units	Flash	×	×	✓	2s	10m	×
TLF-ID L2003	Scale matters: ones	Flash	×	×	✓	2s	10m	×
TLF-ID L2004	Scale matters: tens	Flash	×	×	✓	2s	10m	×
TLF-ID L2321	Number trains: numbers 90–120	Flash	×	×	✓	2s	10m	✓
TLF-ID M015939	Recording numbers	Video	×	×	✓	2s	15m	✓
TLF-ID M017879	MoneySmart: needs and wants	HTML	×	×	✓	2s	5m	×
TLF-ID M019626	Number line, by the Math Learning Centre	iOS 11.4	not available					
TLF-ID M021822	reSolve: Place Value: Number Sorting	PDF	×					
TLF-ID M024880	reSolve: Authentic Problems: Target Ball	PDF	×					

Table D12

Content for ACMNA013 within Content Description Number and Algebra for Year 1.

Content Description Code ID	Title	Content: Manipu-latives	Abstract	Manipulatives /Abstract Mix	Symbols	Numerals	Number Words	Integrated to Other Content
Number and Algebra								
ACMNA013								
TLF-ID L2002	Scale matters: simple units	×	✓	×	×	✓	×	×
TLF-ID L2003	Scale matters: ones	×	✓	×	×	✓	×	×
TLF-ID L2004	Scale matters: tens	×	✓	×	×	✓	×	×
TLF-ID L2321	Number trains: numbers 90–120	×	×	✓	✓	✓	✓	×
TLF-ID M015939	Recording numbers	×	×	×	×	×	×	×
TLF-ID M017879	MoneySmart: needs and wants	×	×	✓	✓	✓	✓	×
TLF-ID M019626	Number line, by the Math Learning Centre							
TLF-ID M021822	reSolve: Place Value: Number Sorting							
TLF-ID M024880	reSolve: Authentic Problems: Target Ball							

Table D13

Learning for ACMNA013 within Content Description Number and Algebra for Year 1.

Content Description Code ID	Title	Learning: Instructions for Student	Instructions for Parent	Learning Objective	Learning Outcome	Feedback to Students	Progress Display	Agility Measurement	Ability Levels	Proficiency Measurement
Number and Algebra										
ACMNA013										
TLF-ID L2002	Scale matters: simple units	×	×	×	×	written	×	×	×	×
TLF-ID L2003	Scale matters: ones	×	×	×	×	written	×	×	×	×
TLF-ID L2004	Scale matters: tens	×	×	×	×	written	×	×	×	×
TLF-ID L2321	Number trains: numbers 90–120	✓	×	×	×	at end	×	×	×	×
TLF-ID M015939	Recording numbers	×	×	×	×	×	×	×	×	×
TLF-ID M017879	MoneySmart: needs and wants	×	×	×	×	written	×	×	×	×
TLF-ID M019626	Number line, by the Math Learning Centre									
TLF-ID M021822	reSolve: Place Value: Number Sorting									
TLF-ID M024880	reSolve: Authentic Problems: Target Ball									

D.2.3 Number and Algebra: Code ACMNA014

Table D14 provides a detailed review of the resources under Code ACMNA014 available on the Curriculum website under the resource heading. Table D15 provides a detailed review of the resources under Code ACMNA014 available on the Curriculum website under the technology heading. Table D16 provides a detailed review of the resources under Code ACMNA014 available on the Curriculum website under the content heading.

Table D17 provides a detailed review of the resources under Code ACMNA014 available on the Curriculum website under the learning heading.

Table D14

Resource for ACMNA014 within Content Description Number and Algebra for Year 1.

Content Description Code ID	Title	Resource: Teacher Resource	Resource: Publisher Author	Resource: Date Created
Number and Algebra				
ACMNA014				
TLF-ID M012235	Hundreds, tens and units		echalk	2012
TLF-ID M017692	Number pieces		clarity	2013
TLF-ID M019622	Number rack, by the Math Learning Centre		MLC	2014
TLF-ID M019628	Number frames, by the Math Learning Centre		MLC	2015
TLF-ID M020069	Importance of zero		ABC	2012
TLF-ID M021154	What is an abacus?		ABC	2016
TLF-ID M021821	reSolve: Addition: Partitioning		AAS	2018

Table D15

Technology for ACMNA014 within Content Description Number and Algebra for Year 1.

Content Description Code ID	Title	Technology: Type	Data Storage	Login Req	Pre-load	Loading Speed	Duration	Audio
Number and Algebra								
ACMNA014								
TLF-ID M012235	Hundreds, tens and units	HTML	×	×	✓	8s	<>	×
TLF-ID M017692	Number pieces	iOS 11.4	not available					
TLF-ID M019622	Number rack, by the Math Learning Centre	iOS 11.4	not available					
TLF-ID M019628	Number frames, by the Math Learning Centre	iOS 11.4	not available					
TLF-ID M020069	Importance of zero	Video	×	×	✓	5s	29s	×
TLF-ID M021154	What is an abacus?	Video	×	×	✓	5s	2.08m	×
TLF-ID M021821	reSolve: Addition: Partitioning	PDF	×					

Table D16

Content for ACMNA014 within Content Description Number and Algebra for Year 1.

Content Description Code ID	Title	Content: Manipu-latives	Abstract	Manipulatives /Abstract Mix	Symbols	Numerals	Number Words	Integrated to Other Content
Number and Algebra								
ACMNA014								
TLF-ID M012235	Hundreds, tens and units	×	×	×	×	×	×	×
TLF-ID M017692	Number pieces							
TLF-ID M019622	Number rack, by the Math Learning Centre							
TLF-ID M019628	Number frames, by the Math Learning Centre							
TLF-ID M020069	Importance of zero	×	×	×	×	×	×	×
TLF-ID M021154	What is an abacus?	×	×	×	×	×	×	×
TLF-ID M021821	reSolve: Addition: Partitioning							

Table D17

Learning for ACMNA014 within Content Description Number and Algebra for Year 1.

Content Description Code ID	Title	Learning								
		Instructions for Student	Instructions for Parent	Learning Objective	Learning Outcome	Feedback to Students	Progress Display	Agility Measurement	Ability Levels	Proficiency Measurement
Number and Algebra										
ACMNA014										
TLF-ID M012235	Hundreds, tens and units	×	×	×	×	×	×	×	×	×
TLF-ID M017692	Number pieces									
TLF-ID M019622	Number rack, by the Math Learning Centre									
TLF-ID M019628	Number frames, by the Math Learning Centre									
TLF-ID M020069	Importance of zero	×	×	×	×	×	×	×	×	×
TLF-ID M021154	What is an abacus?	×	×	×	×	×	×	×	×	×
TLF-ID M021821	reSolve: Addition: Partitioning									

D.2.4 Number and Algebra: Code ACMNA015

Table D18 provides a detailed review of the resources under Code ACMNA015 available on the Curriculum website under the resource heading. Table D19 provides a detailed review of the resources under Code ACMNA015 available on the Curriculum website under the technology heading. Table D20 provides a detailed review of the resources under Code ACMNA015 available on the Curriculum website under the content heading.

Table D21 provides a detailed review of the resources under Code ACMNA015 available on the Curriculum website under the learning heading.

Table D18

Resource for ACMNA015 within Content Description Number and Algebra for Year 1.

Content Description Code ID	Title	Resource		
		Teacher Resource	Publisher Author	Date Created
Number and Algebra				
ACMNA015				
TLF-ID L5975	Balance the cups: use the rule 1		ESA	2013
TLF-ID L8284	Counting beetles: making word problems		2and2	2010
TLF-ID L8285	Counting beetles: solving word problems		2and2	2010
TLF-ID L8304	Pirate treasure hunt: eight challenges		dk2	2016
TLF-ID M014006	Let us count how many	✓	AEF	2012
TLF-ID M015957	Addition: adding numbers from one to ten		ABC	1999
TLF-ID M017301	Counting pirate treasure		ABC	1978
TLF-ID M018955	Elmo's ducks		ABC	2012
TLF-ID M019290	Gobbling Goblins		ABC	2015
TLF-ID M020068	Adding two numbers		ABC	2012
TLF-ID S5662	Mental computation: basic facts - addition subtraction	✓	UTAS	2012

Table D19

Technology for ACMNA015 within Content Description Number and Algebra for Year 1.

Content Description Code ID	Title	Technology: Type	Data Storage	Login Req	Pre-load	Loading Speed	Duration	Audio
Number and Algebra								
ACMNA015								
TLF-ID L5975	Balance the cups: use the rule 1	Flash	×	×	✓	8s	<>	×
TLF-ID L8284	Counting beetles: making word problems	Flash	×	×	✓	8s	<>	×
TLF-ID L8285	Counting beetles: solving word problems	Flash	×	×	✓	8s	<>	×
TLF-ID L8304	Pirate treasure hunt: eight challenges	HTML	×	×	×	45s	<>	✓
TLF-ID M014006	Let us count how many	HTML	×					
TLF-ID M015957	Addition: adding numbers from one to ten	Video	×	×	✓	5s	13.28m	×
TLF-ID M017301	Counting pirate treasure	Video	×	×	✓	5s	3.12m	×
TLF-ID M018955	Elmo's ducks	Video	not available					
TLF-ID M019290	Gobbling Goblins	HTML	×	×	✓	5s	<>	×
TLF-ID M020068	Adding two numbers	Video	×	×	✓	2s	0.24m	×
TLF-ID S5662	Mental computation: basic facts - addition subtraction	PDF	×					

Table D20

Content for ACMNA015 within Content Description Number and Algebra for Year 1.

Content Description Code ID	Title	Content: Manipu-latives	Abstract	Manipulatives /Abstract Mix	Symbols	Numerals	Number Words	Integrated to Other Content
Number and Algebra								
ACMNA015								
TLF-ID L5975	Balance the cups: use the rule 1	×	×	×	×	×	×	×
TLF-ID L8284	Counting beetles: making word problems	×	×	✓	✓	✓	×	×
TLF-ID L8285	Counting beetles: solving word problems	×	×	✓	✓	✓	×	×
TLF-ID L8304	Pirate treasure hunt: eight challenges	×	×	✓	✓	✓	×	×
TLF-ID M014006	Let us count how many							
TLF-ID M015957	Addition: adding numbers from one to ten	×	×	×	×	×	×	×
TLF-ID M017301	Counting pirate treasure	×	×	×	×	×	×	×
TLF-ID M018955	Elmo's ducks							
TLF-ID M019290	Gobbling Goblins	×	×	✓	✓	✓	×	×
TLF-ID M020068	Adding two numbers	×	×	×	×	×	×	×
TLF-ID S5662	Mental computation: basic facts - addition subtraction							

Table D21

Learning for ACMNA015 within Content Description Number and Algebra for Year 1.

Content Description Code ID	Title	Learning: Instructions for Student	Instructions for Parent	Learning Objective	Learning Outcome	Feedback to Students	Progress Display	Agility Measurement	Ability Levels	Proficiency Measurement
Number and Algebra										
ACMNA015										
TLF-ID L5975	Balance the cups: use the rule 1	×	×	×	×	×	×	×	×	×
TLF-ID L8284	Counting beetles: making word problems	✓	×	×	×	✓	×	×	×	×
TLF-ID L8285	Counting beetles: solving word problems	✓	×	×	×	✓	×	×	×	×
TLF-ID L8304	Pirate treasure hunt: eight challenges	✓	×	×	×	✓	×	×	×	×
TLF-ID M014006	Let us count how many									
TLF-ID M015957	Addition: adding numbers from one to ten	×	×	×	×	×	×	×	×	×
TLF-ID M017301	Counting pirate treasure	×	×	×	×	×	×	×	×	×
TLF-ID M018955	Elmo's ducks									
TLF-ID M019290	Gobbling Goblins	✓	×	×	×	×	×	×	×	×
TLF-ID M020068	Adding two numbers	×	×	×	×	×	×	×	×	×
TLF-ID S5662	Mental computation: basic facts - addition subtraction									

D.2.5 Number and Algebra: Code ACMNA016

Table D22 provides a detailed review of the resources under Code ACMNA016 available on the Curriculum website under the resource heading. Table D23 provides a detailed review of the resources under Code ACMNA016 available on the Curriculum website under the technology heading. Table D24 provides a detailed review of the resources under Code ACMNA016 available on the Curriculum website under the content heading. Table D25 provides a detailed review of the resources under Code ACMNA016 available on the Curriculum website under the learning heading.

Table D22

Resource for ACMNA016 within Content Description Number and Algebra for Year 1.

Content Description Code ID	Title	Resource: Teacher Resource	Publisher Author	Date Created
Number and Algebra				
ACMNA016				
TLF-ID M012290	Wholes, halves and quarters		skwirk	2012

Table D23

Technology for ACMNA016 within Content Description Number and Algebra for Year 1.

Content Description Code ID	Title	Technology Type	Data Storage	Login Req	Pre-load	Loading Speed	Duration	Audio
Number and Algebra								
ACMNA016								
TLF-ID M012290	Wholes, halves and quarters	Video	×	×	✓	5s	2.20m	✓

Table D24

Content for ACMNA016 within Content Description Number and Algebra for Year 1.

Content Description Code ID	Title	Content Manipu-latives	Abstract	Manipulatives /Abstract Mix	Symbols	Numerals	Number Words	Integrated to Other Content
Number and Algebra								
ACMNA016								
TLF-ID M012290	Wholes, halves and quarters	×	×	✓	✓	✓	×	×

Table D25

Learning for ACMNA016 within Content Description Number and Algebra for Year 1.

Content Description Code ID	Title	Learning Instructions for Student	Instructions for Parent	Learning Objective	Learning Outcome	Feedback to Students	Progress Display	Agility Measurement	Ability Levels	Proficiency Measurement
Number and Algebra										
ACMNA016										
TLF-ID M012290	Wholes, halves and quarters	×	×	×	×	×	×	×	×	×

D.2.6 Number and Algebra: Code ACMNA017

Table D26 provides a detailed review of the resources under Code ACMNA017 available on the Curriculum website under the resource heading. Table D27 provides a detailed review of the resources under Code ACMNA017 available on the Curriculum website under the technology heading. Table D28 provides a detailed review of the resources under Code ACMNA017 available on the Curriculum website under the content heading. Table D29 provides a detailed review of the resources under Code ACMNA017 available on the Curriculum website under the learning heading.

Table D26

Resource for ACMNA017 within Content Description Number and Algebra for Year 1.

Content Description			Resource		
Code			Teacher Resource	Publisher Author	Date Created
	ID	Title			
Number and Algebra					
ACMNA017					
	TLF-ID M012291	Notes and coins		skwirk	2012
	TLF-ID M013996	Show me your money - years 1 and 2	✓	AEF	2012
	TLF-ID M015364	MoneySmart: Money match		ASIC	2014
	TLF-ID M015366	MoneySmart: Pay the price		ASIC	2013
	TLF-ID M018756	Funny money		ABC	2012
	TLF-ID M019368	Mixed-Up Maths		ABC	2015
	TLF-ID M020173	Money match		ASIC	2013
	TLF-ID M021054	MoneySmart: Maths for primary teachers - PD		ASIC	2017
	TLF-ID M024873	Investigating Australian coins		RAMINT	2018

Table D27

Technology for ACMNA017 within Content Description Number and Algebra for Year 1.

Content Description			Technology						
Code			Type	Data Storage	Login Req	Pre-load	Loading Speed	Duration	Audio
	ID	Title							
Number and Algebra									
ACMNA017									
	TLF-ID M012291	Notes and coins	Video	×	×	✓	5s	2.20m	✓
	TLF-ID M013996	Show me your money - years 1 and 2	HTML	×					
	TLF-ID M015364	MoneySmart: Money match	HTML	×	×	✓	2s	5m	×
	TLF-ID M015366	MoneySmart: Pay the price	HTML	×	×	✓	2s	5m	×
	TLF-ID M018756	Funny money	Video	×	×	✓	2s	5m	×
	TLF-ID M019368	Mixed-Up Maths	Video	×	×	✓	2s	5m	×
	TLF-ID M020173	Money match	HTML	×	×	✓	2s	5m	×
	TLF-ID M021054	MoneySmart: Maths for primary teachers - PD	HTML	×	✓	✓	2s	5m	×
	TLF-ID M024873	Investigating Australian coins	PDF	×					

Table D28

Content for ACMNA017 within Content Description Number and Algebra for Year 1.

Content Description Code ID	Title	Content: Manipu-latives	Abstract	Manipulatives /Abstract Mix	Symbols	Numerals	Number Words	Integrated to Other Content
Number and Algebra								
ACMNA017								
TLF-ID M012291	Notes and coins	×	×	✓	✓	✓	×	×
TLF-ID M013996	Show me your money - years 1 and 2							
TLF-ID M015364	MoneySmart: Money match	×	×	✓	✓	✓	✓	×
TLF-ID M015366	MoneySmart: Pay the price	×	×	✓	✓	✓	✓	×
TLF-ID M018756	Funny money	×	×	✓	✓	✓	✓	×
TLF-ID M019368	Mixed-Up Maths	×	×	✓	✓	✓	✓	×
TLF-ID M020173	Money match	×	×	✓	✓	✓	✓	×
TLF-ID M021054	MoneySmart: Maths for primary teachers - PD	×	×	✓	✓	✓	✓	×
TLF-ID M024873	Investigating Australian coins							

Table D29

Learning for ACMNA017 within Content Description Number and Algebra for Year 1.

Content Description Code ID	Title	Learning: Instructions for Student	Instructions for Parent	Learning Objective	Learning Outcome	Feedback to Students	Progress Display	Agility Measurement	Ability Levels	Proficiency Measurement
Number and Algebra										
ACMNA017										
TLF-ID M012291	Notes and coins	×	×	×	×	×	×	×	×	×
TLF-ID M013996	Show me your money - years 1 and 2									
TLF-ID M015364	MoneySmart: Money match	×	×	×	×	written	×	×	×	×
TLF-ID M015366	MoneySmart: Pay the price	×	×	×	×	written	×	×	×	×
TLF-ID M018756	Funny money	×	×	×	×	written	×	×	×	×
TLF-ID M019368	Mixed-Up Maths	×	×	×	×	written	×	×	×	×
TLF-ID M020173	Money match	×	×	×	×	written	×	×	×	×
TLF-ID M021054	MoneySmart: Maths for primary teachers - PD	×	×	✓	×	written	×	×	×	×
TLF-ID M024873	Investigating Australian coins									

D.2.7 Number and Algebra: Code ACMNA018

Table D30 provides a detailed review of the resources under Code ACMNA018 available on the Curriculum website under the resource heading. Table D31 provides a detailed review of the resources under Code ACMNA018 available on the Curriculum website under the technology heading. Table D32 provides a detailed review of the resources under Code ACMNA018 available on the Curriculum website under the content heading. Table D33 provides a detailed review of the resources under Code ACMNA018 available on the Curriculum website under the learning heading.

Table D30

Resource for ACMNA018 within Content Description Number and Algebra for Year 1.

		Resource		
Content Description Code ID	Title	Teacher Resource	Publisher Author	Date Created
Number and Algebra				
ACMNA018				
TLF-ID L589	Musical number patterns: music maker		CADRE	2016
TLF-ID L1056	Monster choir: making patterns		CADRE	2016
TLF-ID L1057	Monster choir: missing monsters		CADRE	2013
TLF-ID M013921	Top drawer teachers: patterns	✓	ESA	2013
TLF-ID M016224	Sites2See: Patterns and Algebra		NSWDE	2009
TLF-ID R9720	Number trains: counting on	✓	ESA	2013
TLF-ID R10710	Patterns and sequences	✓	TLF	2009

Table D31

Technology for ACMNA018 within Content Description Number and Algebra for Year 1.

		Technology						
Content Description Code ID	Title	Type	Data Storage	Login Req	Pre-load	Loading Speed	Duration	Audio
Number and Algebra								
ACMNA018								
TLF-ID L589	Musical number patterns: music maker	HTML	×	×	✓	20s	<>	✓
TLF-ID L1056	Monster choir: making patterns	HTML	×	×	✓	20s	<>	✓
TLF-ID L1057	Monster choir: missing monsters	HTML	×	×	✓	20s	<>	✓
TLF-ID M013921	Top drawer teachers: patterns	HTML	×					
TLF-ID M016224	Sites2See: Patterns and Algebra	HTML	×	×	×	<>	<>	×
TLF-ID R9720	Number trains: counting on	HTML	×					
TLF-ID R10710	Patterns and sequences	HTML	×					

Table D32

Content for ACMNA018 within Content Description Number and Algebra for Year 1.

		Content						
Content Description Code ID	Title	Manipu-latives	Abstract	Manipulatives /Abstract Mix	Symbols	Numerals	Number Words	Integrated to Other Content
Number and Algebra								
ACMNA018								
TLF-ID L589	Musical number patterns: music maker	×	×	✓	×	✓	×	×
TLF-ID L1056	Monster choir: making patterns	×	×	✓	×	✓	×	×
TLF-ID L1057	Monster choir: missing monsters	×	×	✓	×	✓	×	×
TLF-ID M013921	Top drawer teachers: patterns							
TLF-ID M016224	Sites2See: Patterns and Algebra	×	×	×	✓	✓	×	✓
TLF-ID R9720	Number trains: counting on							
TLF-ID R10710	Patterns and sequences							

Table D33

Learning for ACMNA018 within Content Description Number and Algebra for Year 1.

Content Description Code ID	Title	Learning								
		Instructions for Student	Instructions for Parent	Learning Objective	Learning Outcome	Feedback to Students	Progress Display	Agility Measurement	Ability Levels	Proficiency Measurement
Number and Algebra										
ACMNA018										
TLF-ID L589	Musical number patterns: music maker	✓	×	×	×	✓	×	×	×	×
TLF-ID L1056	Monster choir: making patterns	✓	×	×	×	✓	×	×	×	×
TLF-ID L1057	Monster choir: missing monsters	✓	×	×	×	✓	×	×	×	×
TLF-ID M013921	Top drawer teachers: patterns									
TLF-ID M016224	Sites2See: Patterns and Algebra	✓	✓	×	×	×	×	×	×	×
TLF-ID R9720	Number trains: counting on									
TLF-ID R10710	Patterns and sequences									

D.2.8 Measurement and Geometry: Code ACMMG019

Table D34 provides a detailed review of the resources under Code ACMMG019 available on the Curriculum website under the resource heading. Table D35 provides a detailed review of the resources under Code ACMMG019 available on the Curriculum website under the technology heading. Table D36 provides a detailed review of the resources under Code ACMMG019 available on the Curriculum website under the content heading. Table D37 provides a detailed review of the resources under Code ACMMG019 available on the Curriculum website under the learning heading.

Table D34

Resource for ACMMG019 within Content Description Measurement and Geometry for Year 1.

Content Description Code ID	Title	Resource		
		Teacher Resource	Publisher Author	Date Created
Measurement and Geometry				
ACMMG019				
TLF-IDM024880	reSolve: Authentic Problems: Target Ball	✓	ESA	2018
TLF-IDM020199	Treasure Map | Peg + Cat		ESA	2015
TLF-IDM016665	Sites2See – measurement for primary		NSWDE	2018
TLF-IDM017765	Water for life		ESA	2014

Table D35

Technology for ACMMG019 within Content Description Measurement and Geometry for Year 1.

Content Description Code ID	Title	Technology Type	Data Storage	Login Req	Pre-load	Loading Speed	Duration	Audio
Measurement and Geometry								
ACMMG019								
TLF-IDM024880	reSolve: Authentic Problems: Target Ball	PDF	×					
TLF-IDM020199	Treasure Map | Peg + Cat	Video	×	×	×	2s	3.40m	✓
TLF-IDM016665	Sites2See – measurement for primary	HTML	×	×	×	<>	<>	×
TLF-IDM017765	Water for life	HTML	×	×	✓	<>	<>	✓

Table D36

Content for ACMMG019 within Content Description Measurement and Geometry for Year 1.

Content Description Code ID	Title	Content Manipu-latives	Abstract	Manipulatives /Abstract Mix	Symbols	Numerals	Number Words	Integrated to Other Content
Measurement and Geometry								
ACMMG019								
TLF-IDM024880	reSolve: Authentic Problems: Target Ball							
TLF-IDM020199	Treasure Map | Peg + Cat	×	×	×	✓	✓	✓	×
TLF-IDM016665	Sites2See – measurement for primary	×	×	×	✓	✓	×	✓
TLF-IDM017765	Water for life	×	×	×	✓	✓	✓	×

Table D37

Learning for ACMMG019 within Content Description Measurement and Geometry for Year 1.

Content Description Code ID	Title	Learning Instructions for Student	Instructions for Parent	Learning Objective	Learning Outcome	Feedback to Students	Progress Display	Agility Measurement	Ability Levels	Proficiency Measurement
Measurement and Geometry										
ACMMG019										
TLF-IDM024880	reSolve: Authentic Problems: Target Ball									
TLF-IDM020199	Treasure Map | Peg + Cat	×	×	×	×	×	×	×	×	×
TLF-IDM016665	Sites2See – measurement for primary	✓	✓	×	×	×	×	×	×	×
TLF-IDM017765	Water for life	✓	×	×	×	✓		×	×	×

D.2.9 Measurement and Geometry: Code ACMMG020

Table D38 provides a detailed review of the resources under Code ACMMG020 available on the Curriculum website under the resource heading. Table D39 provides a detailed review of the resources under Code ACMMG020 available on the Curriculum website under the technology heading. Table D40 provides a detailed review of the resources under Code ACMMG020 available on the Curriculum website under the content heading. Table D41 provides a detailed review of the resources under Code ACMMG020 available on the Curriculum website under the learning heading.

Table D38

Resource for ACMMG020 within Content Description Measurement and Geometry for Year 1.

Content Description / Code / ID	Title	Resource: Teacher Resource	Resource: Publisher Author	Resource: Date Created
Measurement and Geometry				
ACMMG020				
TLF-IDL8304	Pirate treasure hunt: eight challenges		ESA	2016
TLF-IDL9644	Time tools: 12-hour to the half hour		ESA	2016
TLF-IDM016665	Sites2See – measurement for primary		NSWDE	2018
TLF-IDS4969	Primary mathematics: games, simulations modelling	✓	ESA	2012
TLF-IDL7796	After school: analogue and digital		ESA	2016
TLF-IDM008610	Measurement and Geometry: time - teacher guide	✓	ESA	2010

Table D39

Technology for ACMMG020 within Content Description Measurement and Geometry for Year 1.

Content Description / Code / ID	Title	Technology: Type	Data Storage	Login Req	Pre-load	Loading Speed	Duration	Audio
Measurement and Geometry								
ACMMG020								
TLF-IDL8304	Pirate treasure hunt: eight challenges	HTML	×	×	✓	50s	10m	✓
TLF-IDL9644	Time tools: 12-hour to the half hour	HTML	×	×	✓	50s	10m	✓
TLF-IDM016665	Sites2See – measurement for primary	HTML	×	×	×	<>	<>	×
TLF-IDS4969	Primary mathematics: games, simulations modelling	HTML	×					
TLF-IDL7796	After school: analogue and digital	HTML	×	×	✓	<>	<>	✓
TLF-IDM008610	Measurement and Geometry: time - teacher guide	PDF	×					

Table D40

Content for ACMMG020 within Content Description Measurement and Geometry for Year 1.

Content Description Code ID	Title	Manipu-latives	Abstract	Manipulatives /Abstract Mix	Symbols	Numerals	Number Words	Integrated to Other Content
Measurement and Geometry								
ACMMG019								
TLF-IDM024880	reSolve: Authentic Problems: Target Ball							
TLF-IDM020199	Treasure Map | Peg + Cat	×	×	×	✓	✓	✓	×
TLF-IDM016665	Sites2See – measurement for primary	×	×	×	✓	✓	×	✓
TLF-IDM017765	Water for life	×	×	×	✓	✓	✓	×
ACMMG020								
TLF-IDL8304	Pirate treasure hunt: eight challenges	×	×	×	✓	✓	✓	×
TLF-IDL9644	Time tools: 12-hour to the half hour	×	×	×	✓	✓	✓	×
TLF-IDM016665	Sites2See – measurement for primary	×	×	×	✓	✓	✓	✓
TLF-IDS4969	Primary mathematics: games, simulations modelling							
TLF-IDL7796	After school: analogue and digital	×	×	×	✓	✓	✓	×
TLF-IDM008610	Measurement and Geometry: time - teacher guide							

Table D41

Learning for ACMMG020 within Content Description Measurement and Geometry for Year 1.

Content Description Code ID	Title	Instructions for Student	Instructions for Parent	Learning Objective	Learning Outcome	Feedback to Students	Progress Display	Agility Measurement	Ability Levels	Proficiency Measurement
Measurement and Geometry										
ACMMG020										
TLF-IDL8304	Pirate treasure hunt: eight challenges	✓	×	×	×	at end	×	×	×	×
TLF-IDL9644	Time tools: 12-hour to the half hour	✓	×	×	×	at end	×	×	×	×
TLF-IDM016665	Sites2See – measurement for primary	✓	✓	×	×	×	×	×	×	×
TLF-IDS4969	Primary mathematics: games, simulations modelling									
TLF-IDL7796	After school: analogue and digital	✓	×	×	×	✓	×	×	×	×
TLF-IDM008610	Measurement and Geometry: time - teacher guide									

D.2.10 Measurement and Geometry: Code ACMMG021

Table D42 provides a detailed review of the resources under Code ACMMG021 available on the Curriculum website under the resource heading. Table D43 provides a detailed review of the resources under Code ACMMG021 available on the Curriculum website under the technology heading. Table D44 provides a detailed review of the resources under Code ACMMG021 available on the Curriculum website under the content heading.

Table D45 provides a detailed review of the resources under Code ACMMG021 available on the Curriculum website under the learning heading.

Table D42

Resource for ACMMG021 within Content Description Measurement and Geometry for Year 1.

Content Description / Code / ID	Title	Resource: Teacher Resource	Resource: Publisher Author	Resource: Date Created
Measurement and Geometry				
ACMMG021				
TLF-IDM019352	A year on a farm	✓	ESA	2015
TLF-IDM016665	Sites2See – measurement for primary		NSWDE	2018
TLF-IDS4969	Primary mathematics: games, simulations modelling	✓	ESA	2012
TLF-IDL7796	After school: analogue and digital		ESA	2016
TLF-IDM008610	Measurement and Geometry: time - teacher guide		ESA	2010

Table D43

Technology for ACMMG021 within Content Description Measurement and Geometry for Year 1.

Content Description / Code / ID	Title	Technology: Type	Data Storage	Login Req	Pre-load	Loading Speed	Duration	Audio
Measurement and Geometry								
ACMMG021								
TLF-IDM019352	A year on a farm	PDF	x					
TLF-IDM016665	Sites2See – measurement for primary	HTML	x	x	x	<>	<>	x
TLF-IDS4969	Primary mathematics: games, simulations modelling	HTML	x					
TLF-IDL7796	After school: analogue and digital	HTML	x	x	<>	<>	✓	✓
TLF-IDM008610	Measurement and Geometry: time - teacher guide	PDF	x					

Table D44

Content for ACMMG021 within Content Description Measurement and Geometry for Year 1.

Content Description / Code / ID	Title	Content: Manipu-latives	Abstract	Manipulatives /Abstract Mix	Symbols	Numerals	Number Words	Integrated to Other Content
Measurement and Geometry								
ACMMG021								
TLF-IDM019352	A year on a farm							
TLF-IDM016665	Sites2See – measurement for primary	x	x	x	✓	✓	x	✓
TLF-IDS4969	Primary mathematics: games, simulations modelling							
TLF-IDL7796	After school: analogue and digital	x	x	x	✓	✓	x	x
TLF-IDM008610	Measurement and Geometry: time - teacher guide							

Table D45

Learning for ACMMG021 within Content Description Measurement and Geometry for Year 1.

Content Description		Learning								
Code ID	Title	Instructions for Student	Instructions for Parent	Learning Objective	Learning Outcome	Feedback to Students	Progress Display	Agility Measurement	Ability Levels	Proficiency Measurement
Measurement and Geometry										
ACMMG021										
TLF-IDM019352	A year on a farm									
TLF-IDM016665	Sites2See – measurement for primary	✓	✓	×	×	×	×	×	×	×
TLF-IDS4969	Primary mathematics: games, simulations modelling									
TLF-IDL7796	After school: analogue and digital	×	×	×	✓	×	×	✓	✓	×
TLF-IDM008610	Measurement and Geometry: time - teacher guide									

D.2.11 Measurement and Geometry: Code ACMMG022

Table D46 provides a detailed review of the resources under Code ACMMG022 available on the Curriculum website under the resource heading. Table D47 provides a detailed review of the resources under Code ACMMG022 available on the Curriculum website under the technology heading. Table D48 provides a detailed review of the resources under Code ACMMG022 available on the Curriculum website under the content heading. Table D49 provides a detailed review of the resources under Code ACMMG022 available on the Curriculum website under the learning heading.

Table D46

Resource for ACMMG022 within Content Description Measurement and Geometry for Year 1.

Content Description		Resource		
Code ID	Title	Teacher Resource	Publisher Author	Date Created
Measurement and Geometry				
ACMMG022				
TLF-IDM021823	reSolve: Shape: Shadows	✓	ESA	2018
TLF-IDM016317	Sites2See: Space and Geometry for Primary		NSWDE	2013
TLF-IDS4970	Primary mathematics: open-ended tasks	✓	ESA	2012
TLF-IDL8167	Shape sorter: polygons		ESA	2016

Table D47

Technology for ACMMG022 within Content Description Measurement and Geometry for Year 1.

Content Description / Code / ID	Title	Technology: Type	Data Storage	Login Req	Pre-load	Loading Speed	Duration	Audio
Measurement and Geometry								
ACMMG022								
TLF-IDM021823	reSolve: Shape: Shadows	HTML						
TLF-IDM016317	Sites2See: Space and Geometry for Primary	HTML	×	×	×	<>	<>	×
TLF-IDS4970	Primary mathematics: open-ended tasks	HTML	×					
TLF-IDL8167	Shape sorter: polygons	HTML	×	×	<>	<>	✓	✓

Table D48

Content for ACMMG022 within Content Description Measurement and Geometry for Year 1.

Content Description / Code / ID	Title	Content: Manipu-latives	Abstract	Manipulatives /Abstract Mix	Symbols	Numerals	Number Words	Integrated to Other Content
Measurement and Geometry								
ACMMG022								
TLF-IDM021823	reSolve: Shape: Shadows							
TLF-IDM016317	Sites2See: Space and Geometry for Primary	×	×	×	✓	✓	×	✓
TLF-IDS4970	Primary mathematics: open-ended tasks							
TLF-IDL8167	Shape sorter: polygons	×	×	×	✓	✓	×	×

Table D49

Learning for ACMMG022 within Content Description Measurement and Geometry for Year 1.

Content Description / Code / ID	Title	Learning: Instructions for Student	Instructions for Parent	Learning Objective	Learning Outcome	Feedback to Students	Progress Display	Agility Measurement	Ability Levels	Proficiency Measurement
Measurement and Geometry										
ACMMG022										
TLF-IDM021823	reSolve: Shape: Shadows									
TLF-IDM016317	Sites2See: Space and Geometry for Primary	✓	✓	×	×	×	×	×	×	×
TLF-IDS4970	Primary mathematics: open-ended tasks									
TLF-IDL8167	Shape sorter: polygons	×	×	×	✓	×	×	✓	✓	×

D.2.12 Measurement and Geometry: Code ACMMG023

Table D50 provides a detailed review of the resources under Code ACMMG023 available on the Curriculum website under the resource heading. Table D51 provides a detailed review of the resources under Code ACMMG023 available on the Curriculum website under the technology heading. Table D52 provides a detailed review of the resources under Code

ACMMG023 available on the Curriculum website under the content heading. Table D53 provides a detailed review of the resources under Code ACMMG023 available on the Curriculum website under the learning heading.

Table D50

Resource for ACMMG023 within Content Description Measurement and Geometry for Year 1.

Content Description			Resource		
Code	ID	Title	Teacher Resource	Publisher Author	Date Created
Measurement and Geometry					
ACMMG023					
	TLF-IDM016317	Sites2See: Space and Geometry for Primary		NSWDE	2013
	TLF-IDM019648	Scratch Jr		ESA	2014
	TLF-IDM019653	Blue-bot		ESA	2012
	TLF-IDM019649	Scratch Jr		ESA	2021
	TLF-IDM019650	The Foos: Free Code Hour		ESA	2021

Table D51

Technology for ACMMG023 within Content Description Measurement and Geometry for Year 1.

Content Description			Technology						
Code	ID	Title	Type	Data Storage	Login Req	Pre-load	Loading Speed	Duration	Audio
Measurement and Geometry									
ACMMG023									
	TLF-IDM016317	Sites2See: Space and Geometry for Primary	HTML	×	×	×	<>	<>	×
	TLF-IDM019648	Scratch Jr	iOS 9.3	not available					
	TLF-IDM019653	Blue-bot	iOS 9.0	not available					
	TLF-IDM019649	Scratch Jr	Android	not available					
	TLF-IDM019650	The Foos: Free Code Hour	Android	not available					

Table D52

Content for ACMMG023 within Content Description Measurement and Geometry for Year 1.

Content Description			Content						
Code	ID	Title	Manipu-latives	Abstract	Manipulatives /Abstract Mix	Symbols	Numerals	Number Words	Integrated to Other Content
Measurement and Geometry									
ACMMG023									
	TLF-IDM016317	Sites2See: Space and Geometry for Primary	×	×	×	✓	✓	×	✓
	TLF-IDM019648	Scratch Jr							
	TLF-IDM019653	Blue-bot							
	TLF-IDM019649	Scratch Jr							
	TLF-IDM019650	The Foos: Free Code Hour							

Table D53

Learning for ACMMG023 within Content Description Measurement and Geometry for Year 1.

Content Description / Code / ID	Title	Learning: Instructions for Student	Instructions for Parent	Learning Objective	Learning Outcome	Feedback to Students	Progress Display	Agility Measurement	Ability Levels	Proficiency Measurement
Measurement and Geometry										
ACMMG023										
TLF-IDM016317	Sites2See: Space and Geometry for Primary	✓	✓	×	×	×	×	×	×	×
TLF-IDM019648	Scratch Jr									
TLF-IDM019653	Blue-bot									
TLF-IDM019649	Scratch Jr									
TLF-IDM019650	The Foos: Free Code Hour									

D.2.13 Statistics and Probability: Code ACMSP024

Table D54 provides a detailed review of the resources under Code ACMSP024 available on the Curriculum website under the resource heading. Table D55 provides a detailed review of the resources under Code ACMSP024 available on the Curriculum website under the technology heading. Table D56 provides a detailed review of the resources under Code ACMSP024 available on the Curriculum website under the content heading. Table D57 provides a detailed review of the resources under Code ACMSP024 available on the Curriculum website under the learning heading.

Table D54

Resource for ACMMG024 within Content Description Statistics and Probability for Year 1.

Content Description / Code / ID	Title	Resource: Teacher Resource	Publisher Author	Date Created
Statistics and Probability				
ACMSP024				
TLF-IDL115	The slushy sludger: questions		ESA	2016

Table D55

Technology for ACMMG024 within Content Description Statistics and Probability for Year 1.

Content Description Code ID	Title	Technology: Type	Data Storage	Login Req	Pre-load	Loading Speed	Duration	Audio
Statistics and Probability								
ACMSP024								
TLF-IDL115	The slushy sludger: questions	HTML	×	×	<>	<>	✓	✓

Table D56

Content for ACMMG024 within Content Description Statistics and Probability for Year 1.

Content Description Code ID	Title	Content: Manipu-latives	Abstract	Manipulatives /Abstract Mix	Symbols	Numerals	Number Words	Integrated to Other Content
Statistics and Probability								
ACMSP024								
TLF-IDL115	The slushy sludger: questions	×	×	×	✓	✓	×	×

Table D57

Learning for ACMMG024 within Content Description Statistics and Probability for Year 1.

Content Description Code ID	Title	Learning: Instructions for Student	Instructions for Parent	Learning Objective	Learning Outcome	Feedback to Students	Progress Display	Agility Measurement	Ability Levels	Proficiency Measurement
Statistics and Probability										
ACMSP024										
TLF-IDL115	The slushy sludger: questions	×	×	×	✓	×	×	✓	✓	×

D.2.14 Statistics and Probability: Code ACMSP062

Table D58 provides a detailed review of the resources under Code ACMSP062 available on the Curriculum website under the resource heading. Table D59 provides a detailed review of the resources under Code ACMSP062 available on the Curriculum website under the technology heading. Table D60 provides a detailed review of the resources under Code ACMSP062 available on the Curriculum website under the content heading.

Table D61 provides a detailed review of the resources under Code ACMSP062 available on the Curriculum website under the learning heading.

Table D58

Resource for ACMMG062 within Content Description Statistics and Probability for Year 1.

Content Description Code ID	Title	Teacher Resource	Publisher Author	Date Created
Statistics and Probability				
ACMSP262				
TLF-IDM025303	reSolve: Statistics - Planning Playgrounds	✓	ESA	2019
TLF-IDM024880	reSolve: Authentic Problems: Target Ball	✓	ESA	2018
TLF-IDM019352	A year on a farm	✓	ESA	2015
TLF-IDM020672	Bear and Chook by the Sea	✓	NSWDE	2017

Table D59

Technology for ACMMG062 within Content Description Statistics and Probability for Year 1.

Content Description Code ID	Title	Type	Data Storage	Login Req	Pre-load	Loading Speed	Duration	Audio
Statistics and Probability								
ACMSP262								
TLF-IDM025303	reSolve: Statistics - Planning Playgrounds	PDF	×					
TLF-IDM024880	reSolve: Authentic Problems: Target Ball	PDF	×					
TLF-IDM019352	A year on a farm	PDF	×					
TLF-IDM020672	Bear and Chook by the Sea	HTML	×					

Table D60

Content for ACMMG062 within Content Description Statistics and Probability for Year 1.

Content Description Code ID	Title	Manipu-latives	Abstract	Manipulatives /Abstract Mix	Symbols	Numerals	Number Words	Integrated to Other Content
Statistics and Probability								
ACMSP262								
TLF-IDM025303	reSolve: Statistics - Planning Playgrounds							
TLF-IDM024880	reSolve: Authentic Problems: Target Ball							
TLF-IDM019352	A year on a farm							
TLF-IDM020672	Bear and Chook by the Sea							

Table D61

Learning for ACMMG062 within Content Description Statistics and Probability for Year 1.

Content Description Code ID	Title	Learning: Instructions for Student	Instructions for Parent	Learning Objective	Learning Outcome	Feedback to Students	Progress Display	Agility Measurement	Ability Levels	Proficiency Measurement
Statistics and Probability										
ACMSP262										
TLF-IDM025303	reSolve: Statistics - Planning Playgrounds									
TLF-IDM024880	reSolve: Authentic Problems: Target Ball									
TLF-IDM019352	A year on a farm									
TLF-IDM020672	Bear and Chook by the Sea									

D.2.15 Statistics and Probability: Code ACMSP063

Table D63 provides a detailed review of the resources under Code ACMSP063 available on the Curriculum website under the resource heading. Table D64 provides a detailed review of the resources under Code ACMSP063 available on the Curriculum website under the technology heading. Table D65 provides a detailed review of the resources under Code ACMSP063 available on the Curriculum website under the content heading. Table D66 provides a detailed review of the resources under Code ACMSP063 available on the Curriculum website under the learning heading.

Table D62

Resource for ACMMG063 within Content Description Statistics and Probability for Year 1.

Content Description Code ID	Title	Resource		
		Teacher Resource	Publisher Author	Date Created
Statistics and Probability				
ACMSP263				
TLF-IDM020216	Peg + Cat: Sort the recycling		ESA	2015
TLF-IDM025303	reSolve: Statistics - Planning Playgrounds	✓	ESA	2019
TLF-IDM024880	reSolve: Authentic Problems: Target Ball	✓	ESA	2018
TLF-IDM020672	Bear and Chook by the Sea	✓	NSWDE	2017
TLF-IDM020218	How many birds?		ESA	2015
TLF-IDS4970	Primary mathematics: open-ended tasks	✓	ESA	2012
TLF-IDL589	Musical number patterns: music maker		ESA	2016
TLF-IDL8459	Wishball challenge: tens		ESA	2016
TLF-IDM024877	reSolve: Authentic Problems: Grandma's Soup	✓	ESA	2018
TLF-IDM021822	reSolve: Place Value: Number Sorting	✓	ESA	2018
TLF-IDM008811	Number and Algebra: addition & subtraction	✓	ESA	2011
TLF-IDM017866	MoneySmart: Bertie's socks	✓	ESA	2015
TLF-IDM016665	Sites2See – measurement for primary		NSWDE	2018

Table D63

Technology for ACMMG032 within Content Description Statistics and Probability for Year 1.

Content Description Code ID	Title	Technology						
		Type	Data Storage	Login Req	Pre-load	Loading Speed	Duration	Audio
Statistics and Probability								
ACMSP263								
TLF-IDM020216	Peg + Cat: Sort the recycling	Video	x	x	x	2s	2.48m	✓
TLF-IDM025303	reSolve: Statistics - Planning Playgrounds	PDF	x					
TLF-IDM024880	reSolve: Authentic Problems: Target Ball	PDF	x					
TLF-IDM020672	Bear and Chook by the Sea	HTML	x					
TLF-IDM020218	How many birds?	Video	x	x	x	2s	2.06m	✓
TLF-IDS4970	Primary mathematics: open-ended tasks	HTML	x					
TLF-IDL589	Musical number patterns: music maker	HTML	x	x	<>	<>	✓	✓
TLF-IDL8459	Wishball challenge: tens	HTML	x	x	<>	<>	✓	✓
TLF-IDM024877	reSolve: Authentic Problems: Grandma's Soup	PDF	x					
TLF-IDM021822	reSolve: Place Value: Number Sorting	PDF	x					
TLF-IDM008811	Number and Algebra: addition & subtraction	HTML	x					
TLF-IDM017866	MoneySmart: Bertie's socks	HTML	x					
TLF-IDM016665	Sites2See – measurement for primary	HTML	x	x	x	<>	<>	x

Table D64

Content for ACMMG032 within Content Description Statistics and Probability for Year 1.

Content Description Code ID	Title	Manipu-latives	Abstract	Manipulatives /Abstract Mix	Symbols	Numerals	Number Words	Integrated to Other Content
		Content						
Statistics and Probability								
ACMSP263								
TLF-IDM020216	Peg + Cat: Sort the recycling	×	×	×	✓	✓	✓	×
TLF-IDM025303	reSolve: Statistics - Planning Playgrounds							
TLF-IDM024880	reSolve: Authentic Problems: Target Ball							
TLF-IDM020672	Bear and Chook by the Sea							
TLF-IDM020218	How many birds?	×	×	×	✓	✓	✓	×
TLF-IDS4970	Primary mathematics: open-ended tasks							
TLF-IDL589	Musical number patterns: music maker	×	×	×	✓	✓	×	×
TLF-IDL8459	Wishball challenge: tens	×	×	×	✓	✓	×	×
TLF-IDM024877	reSolve: Authentic Problems: Grandma's Soup							
TLF-IDM021822	reSolve: Place Value: Number Sorting							
TLF-IDM008811	Number and Algebra: addition & subtraction							
TLF-IDM017866	MoneySmart: Bertie's socks							
TLF-IDM016665	Sites2See – measurement for primary	×	×	×	✓	✓	×	✓

Table D65

Learning for ACMMG032 within Content Description Statistics and Probability for Year 1.

Content Description Code ID	Title	Instructions for Student	Instructions for Parent	Learning Objective	Learning Outcome	Feedback to Students	Progress Display	Agility Measurement	Ability Levels	Proficiency Measurement
		Learning								
Statistics and Probability										
ACMSP263										
TLF-IDM020216	Peg + Cat: Sort the recycling	×	×	×	×	×	×	×	×	×
TLF-IDM025303	reSolve: Statistics - Planning Playgrounds									
TLF-IDM024880	reSolve: Authentic Problems: Target Ball									
TLF-IDM020672	Bear and Chook by the Sea									
TLF-IDM020218	How many birds?	×	×	×	×	×	×	×	×	×
TLF-IDS4970	Primary mathematics: open-ended tasks									
TLF-IDL589	Musical number patterns: music maker	×	×	×	✓	×	×	✓	✓	×
TLF-IDL8459	Wishball challenge: tens	×	×	×	✓	×	×	✓	✓	×
TLF-IDM024877	reSolve: Authentic Problems: Grandma's Soup									
TLF-IDM021822	reSolve: Place Value: Number Sorting									
TLF-IDM008811	Number and Algebra: addition & subtraction									
TLF-IDM017866	MoneySmart: Bertie's socks									
TLF-IDM016665	Sites2See – measurement for primary	✓	✓	×	×	×	×	×	×	×

Appendix E

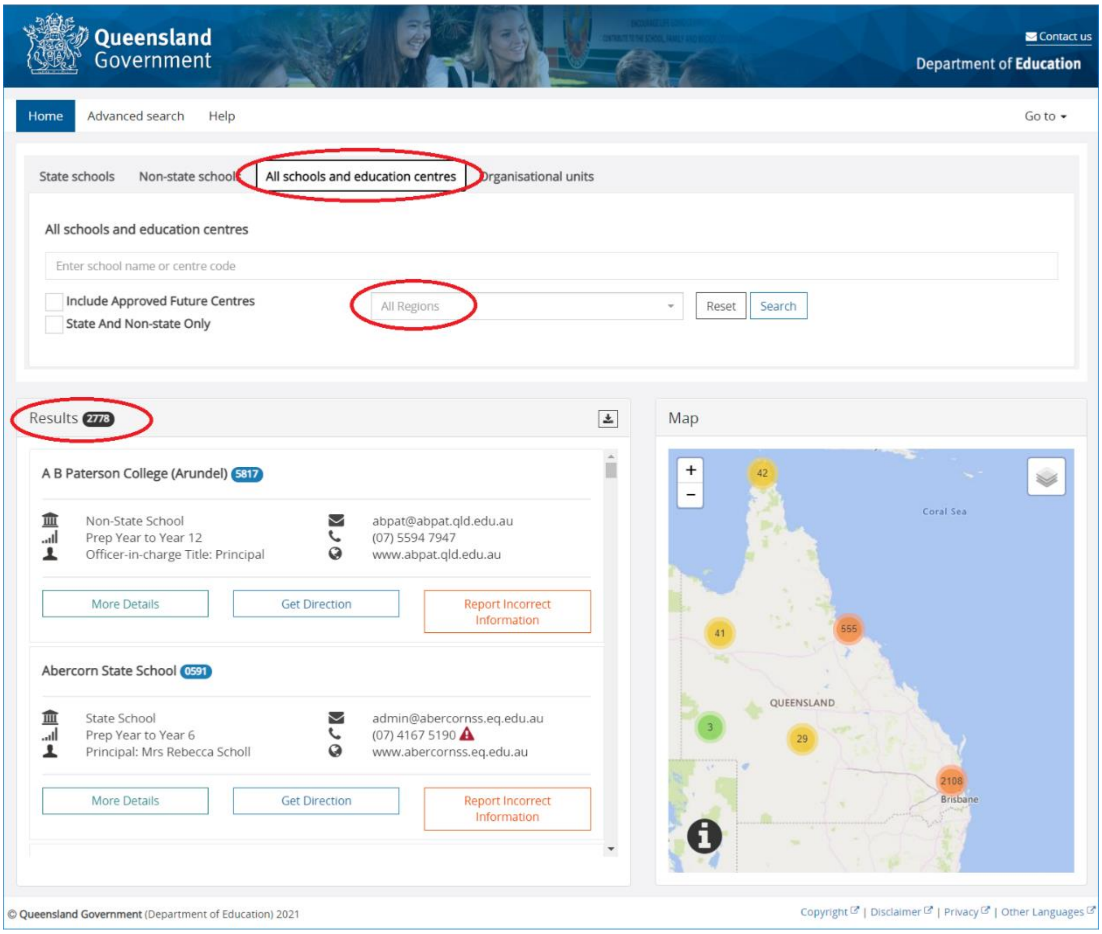
Queensland Government, NCEC, ISQ Websites

The screenshots in this Appendix are from the publicly accessible websites of:

- Queensland Government Schools Directory (October 2021) https://schoolsdirectory.eq.edu.au.
- National Catholic Education Commission (October 2021) https://www.ncec.catholic.edu.au
- Independent Schools Queensland (October 2021) https://www.isq.qld.edu.au

Figure E1

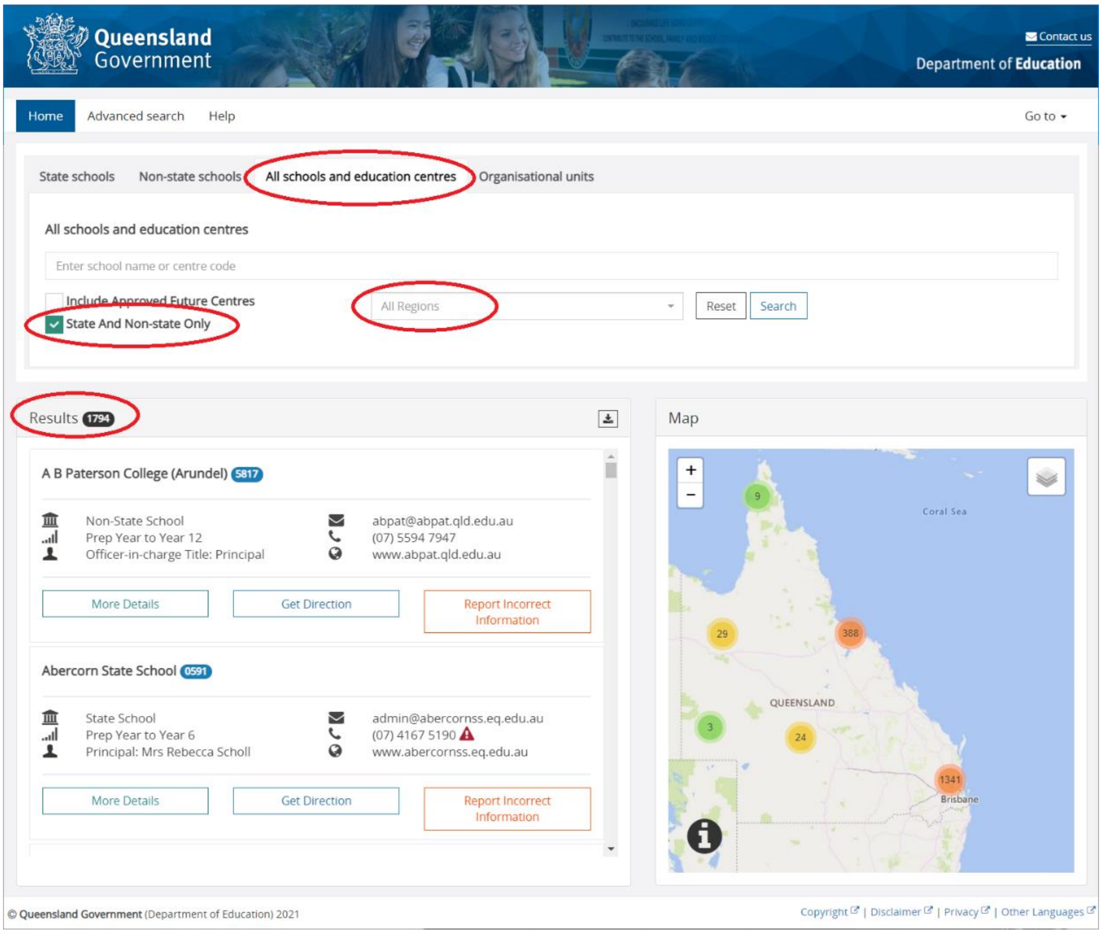
All Queensland Schools and Education Centres



Note. Figure E1 shows all Queensland schools and education centres selected for all regions with results of 2,778. From Queensland Government, 2021 (https://schoolsdirectory.eq.edu.au).

Figure E2

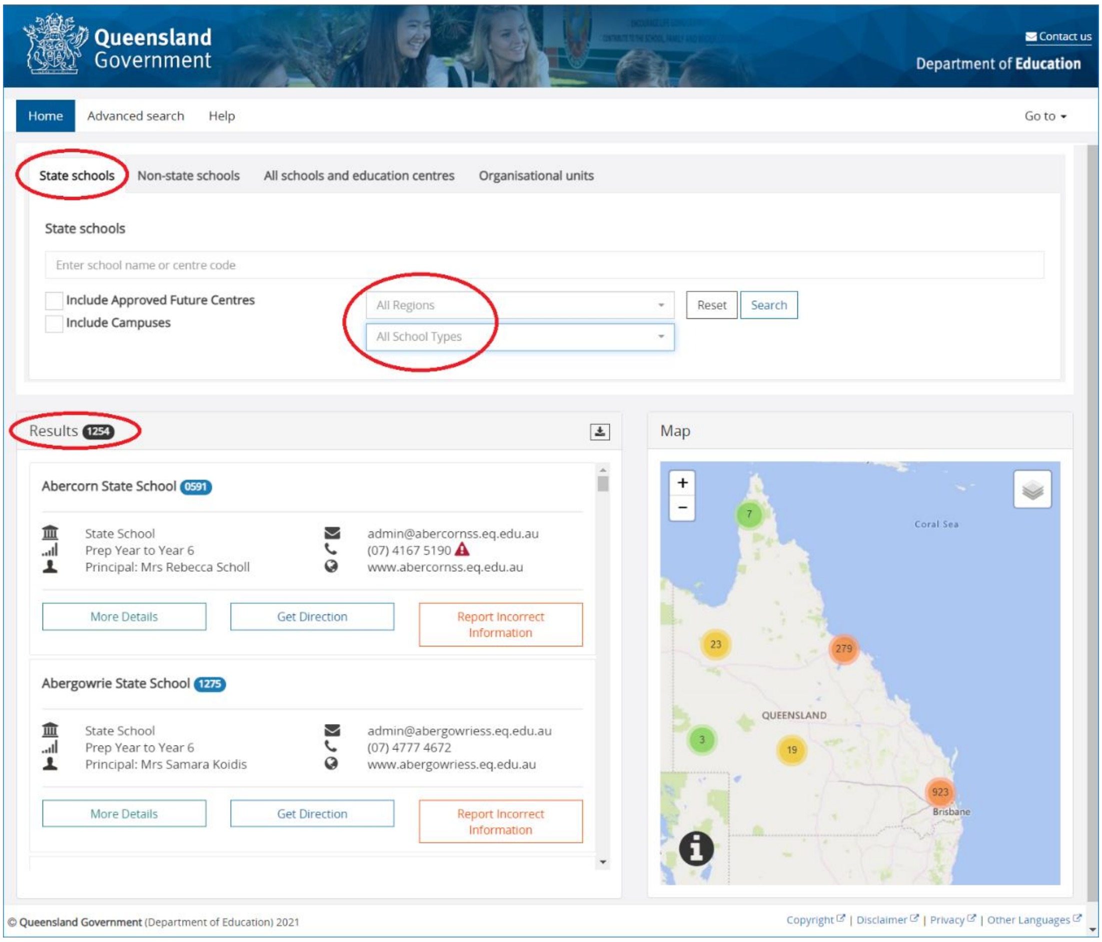
Queensland State and Non-State School Types



Note. Figure E2 shows all Queensland State and Non-State School Types for all regions with results of 1,794. From Queensland Government, 2021 (https://schoolsdirectory.eq.edu.au).

Figure E3

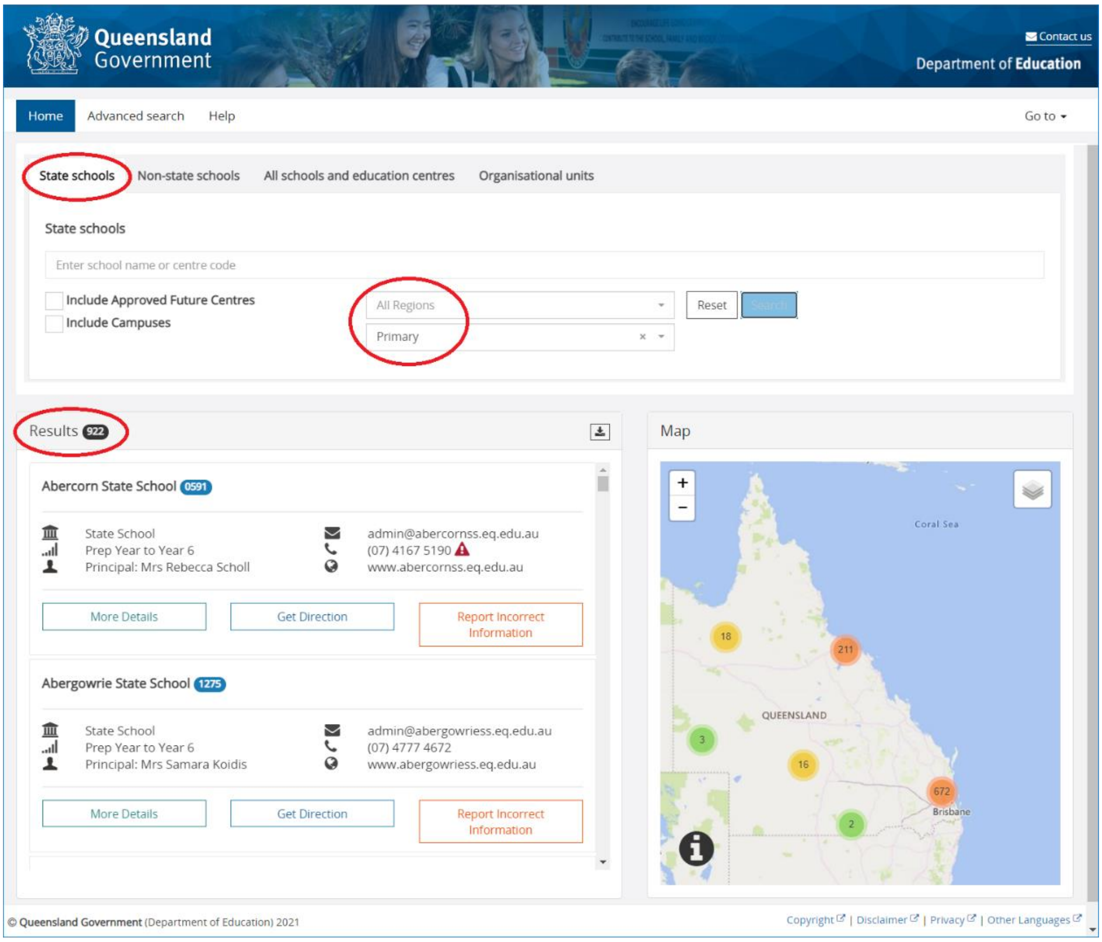
Queensland State Schools



Note. Figure E3 shows all Queensland State Schools for all regions with results of 1,254. From Queensland Government, 2021 (https://schoolsdirectory.eq.edu.au).

Figure E4

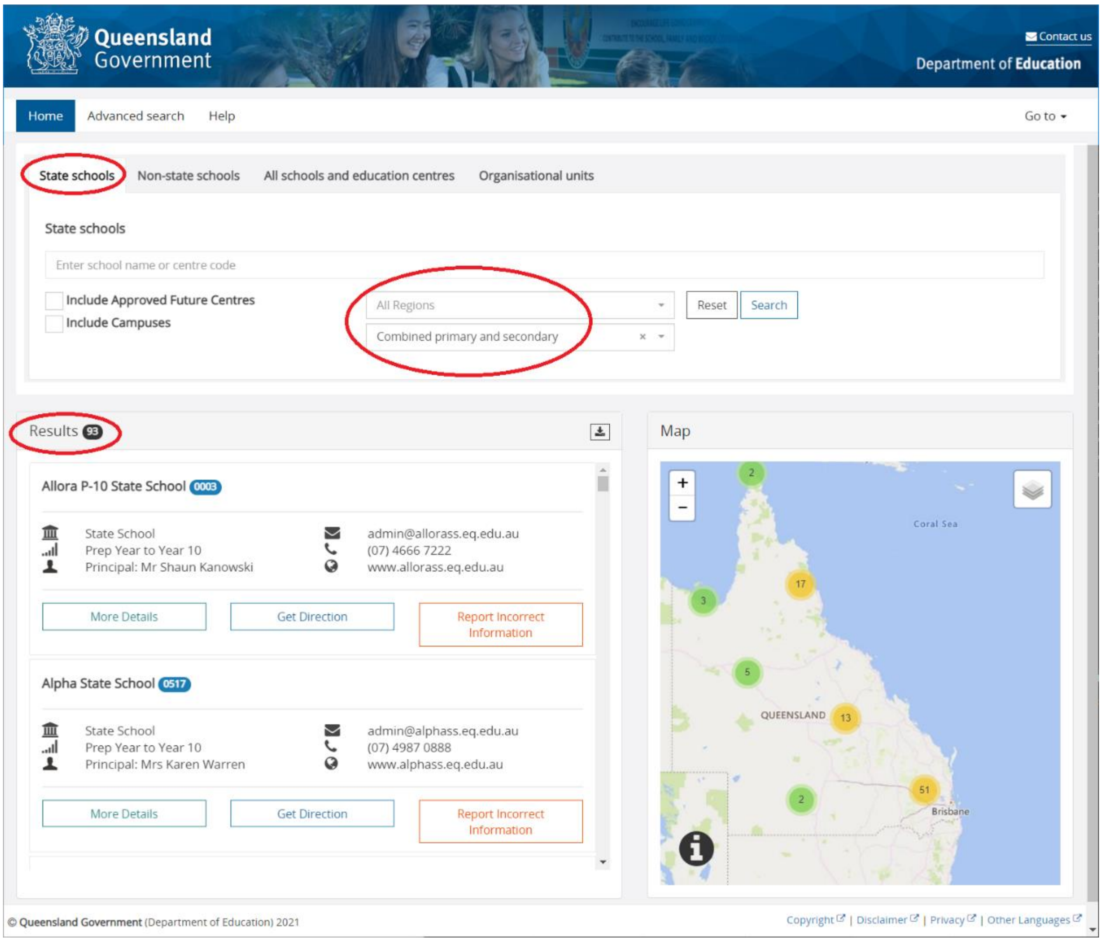
Queensland State Primary Schools



Note. Figure E4 shows all Queensland State Primary Schools for all regions with results of 922. From Queensland Government, 2021 (https://schoolsdirectory.eq.edu.au).

Figure E5

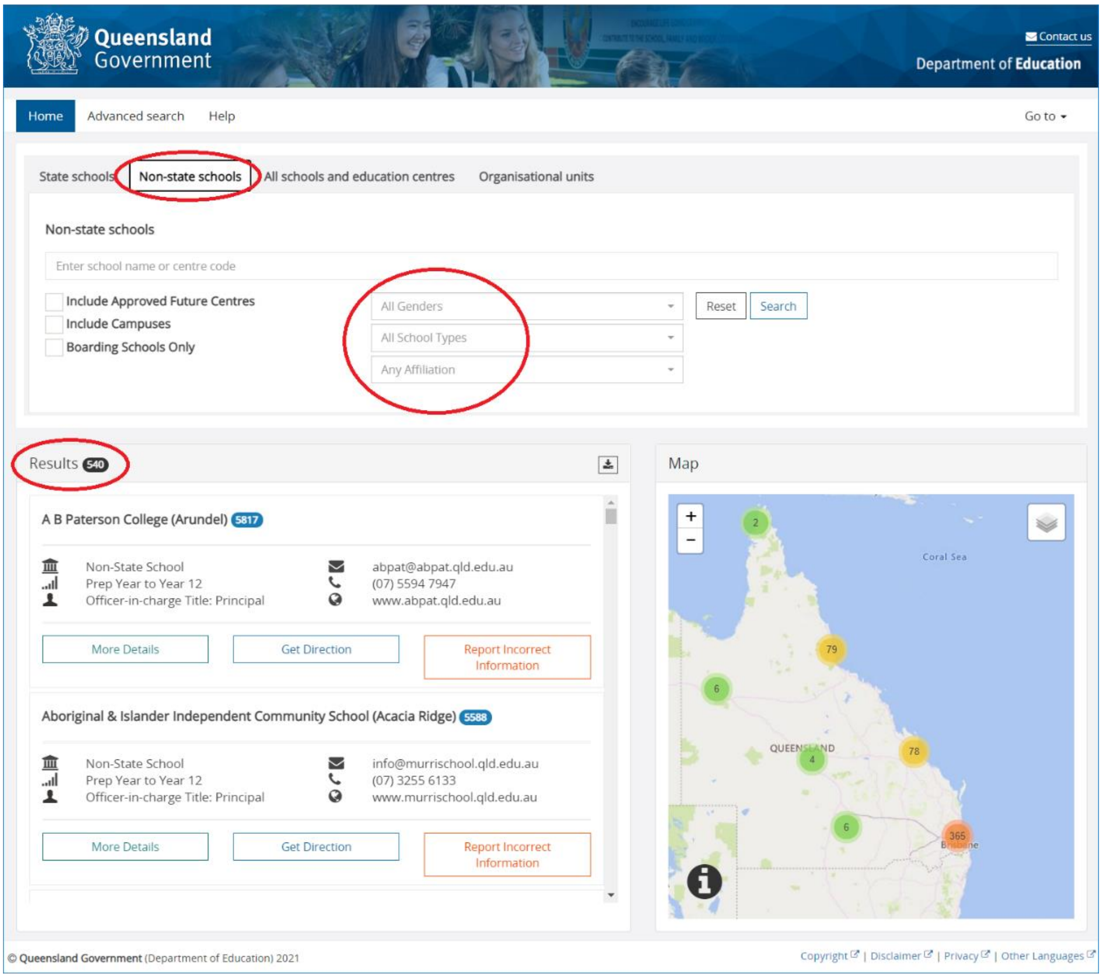
Queensland State Combined (Primary & Secondary) Schools



Note. Figure E5 shows all Queensland State Combined (Primary and Secondary) Schools for all regions with results of 93. From Queensland Government, 2021 (https://schoolsdirectory.eq.edu.au). © 2021 Queensland Government (Department of Education) 2021, all rights reserved.

Figure E6

Queensland Non-State School Types



Note. Figure E6 shows all Queensland Non-State School Types for all regions, all genders, and any affiliation with results of 540. From Queensland Government, 2021 (https://schoolsdirectory.eq.edu.au). © 2021 Queensland Government (Department of Education) 2021, all rights reserved.

Figure E7

Queensland Catholic Member School Characteristics

School type

Primary, secondary, combined and special schools

Primary and secondary schools are those schools that have (only) primary or (only) secondary students enrolled, although the grade range for primary and secondary students varies between states and territories and across time. In South Australia, for example, Year 7 students in primary schools counted as "primary" students in 2018 whereas Year 7 students in combined and special schools counted as "secondary" students. In all other states and territories all Year 7 students are "secondary" students. Combined schools educate both primary and secondary students.

Special schools are designated by the relevant state or territory education authority as schools catering predominantly to students who have one or more of the following characteristics: intellectual or physical disability, hearing or vision impairment, autism, or a diagnosed social/emotional deficit. Schools such as intensive language centres, schools where the distinguishing feature is the lack of a formal curriculum, schools for exceptionally gifted or talented students, distance education schools and special assistance schools that cater primarily for students with social, emotional or behavioural difficulties are not special schools.

In 2018, Catholic education was provided in 1,246 primary schools, 351 secondary schools, 138 combined primary/secondary schools and 11 special schools (Table 2). While the majority (71.4%) of Catholic schools in Australia are primary there are significant differences in the share of primary schools across the states and territories, varying from 44.4% in the Northern Territory to 79.0% in Victoria. In contrast, the Northern Territory has the highest proportion of secondary schools (27.8%) and combined schools (27.8%). Catholic special schools are present in small numbers in only 3 jurisdictions (totalling 11 schools nationally) (***Table 2***).

Table 2: *School type by state and territory, 2018*

State/territory	*Primary*	*Secondary*	*Combined*	*Special*	*Primary %*	*Secondary %*	*Combined %*	*Special %*	*Total %*
Australian Capital Territory	24	6	2	-	75.0%	18.8%	6.3%	-	100.0%
New South Wales	424	135	29	7	71.3%	22.7%	4.9%	1.2%	100.0%
Northern Territory	8	5	5	-	44.4%	27.8%	27.8%	-	100.0%
Queensland	196	75	33	-	64.5%	24.7%	10.9%	-	100.0%
South Australia	67	10	23	2	65.7%	9.8%	22.5%	2.0%	100.0%
Tasmania	24	6	8	-	63.2%	15.8%	21.1%	-	100.0%
Victoria	391	88	14	2	79.0%	17.8%	2.8%	0.4%	100.0%
Western Australia	112	26	24	-	69.1%	16.0%	14.8%	-	100.0%
Australia	1,246	351	138	11	71.4%	20.1%	7.9%	0.6%	100.0%

Almost 40% of Catholic schools are located outside major cities (***Table 3***). Primary schools dominate in every region while other types of schools varying by remoteness. Combined primary/secondary schools are more common in outer regional and remote areas - all secondary education in very remote Australia takes place in combined schools. In contrast, special schools are located only in major cities.

Table 3*: School type by remoteness category, 2018*

Remoteness category	*Primary*	*Secondary*	*Combined*	*Special*	*All schools*	*Primary %*	*Secondary %*	*Combined %*	*Special %*	*All schools %*
Major cities	766	235	73	11	1,085	70.6%	21.7%	6.7%	1.0%	62.1%
Inner regional	279	80	26	-	385	72.5%	20.8%	6.8%	-	22.1%
Outer regional	156	29	23	-	208	75.0%	13.9%	11.1%	-	11.9%
Remote	26	7	7	-	40	65.0%	17.5%	17.5%	-	2.3%
Very remote	19	-	9	-	28	67.9%	-	32.1%	-	1.6%
Australia	1,246	351	138	11	1,746	71.4%	20.1%	7.9%	0.6%	100.0%

Since 1985 the growth in combined schools has exceeded that of other school types (***Table 4, Table 5, Table 6***). In South Australia growth in combined schools of 43.8% corresponded with a decline in both primary and secondary schools over the period of 8.2% and 28.6% respectively, while Tasmania experienced the largest decline in primary schools (down 17.2%).

Although growth has been strongest nationally for combined schools, the number of combined schools declined between 1985 and 2018 in four jurisdictions, including the Australian Capital Territory (down 33.3%), New South Wales (down 23.7%), the Northern Territory (down 16.7%) and Victoria (down 6.7%).

Australian Catholic Schools 2019 Page 7

Note. Figure E7 shows all Queensland Catholic Member School Characteristics for all regions, and all genders, with results of 196 Primary Schools, and 33 Combined (Primary and Secondary) Schools. From Australian Catholic Schools, 2019 (https://www.ncec.catholic.edu.au/schools/catholic-school-statistics/571-catholic-schools-in-australia-2019-1/file).

Figure E8

Queensland Independent Member School Characteristics

The number of member schools or schools with a service agreement with Independent Schools Queensland (ISQ) reached 228 in 2020. Member schools operate from 262 sites throughout Queensland, reflecting a number of schools having more than one campus.

The makeup of the membership includes 223 independent schools (130,481 total enrolment) and five Catholic schools (4,033 total enrolment). Together these member schools cater for 134,514 students from Prep to Year 12, or 15.7% of all school students in the state. All non-Catholic independent schools in Queensland are members of ISQ.

- Over two-thirds of ISQ's member schools (69%) offer both primary and secondary schooling (157 of the 228 member schools, including all four Special schools).
- The 153 non-special schools that offer both primary and secondary schooling cater for 118,054 students – nearly 88% of all students at member schools. Twenty-eight primary-only and 43 secondary-only schools cater for another 4,662 students and 11,418 students, respectively, while four Special schools cater for 380 students.
- Most of ISQ's member schools offer schooling in a co-educational setting (203 schools). However, 25 schools offer single-gender schooling (16 girls-only schools and nine boys-only schools). Approximately 17% of all students attending member schools attended single-gender schools.
- There are 1,718 students attending member schools that are overseas students. These students attend 84 schools. These 84 schools together cater for 89% of all overseas students attending non-government schools in Queensland.
- ISQ's membership includes 11 schools that offer distance education. Together these schools cater for 4,025 students (3.0% of all students attending member schools are distance education students).
- Thirty-six member schools enrol boarding students. These schools cater for 3,885 boarders, representing 2.9% of all students attending member schools. These schools cater for 70% of all boarding students attending non-government schools in Queensland.
- Indigenous students are enrolled at 214 member schools (94% of member schools). These students represent 4.0% of students attending member schools.
- Twenty-six schools, known as Special Assistance Schools, cater for disengaged youth. These schools represent 11% of member schools and together cater for 2.2% of students attending member schools.

Table 1: Member School Characteristics

Sub-Category	Number of Member Schools	Students at Member Schools Number	%
SCHOOL STRUCTURE TYPE			
Combined (Primary & Secondary)	153	118,054	87.8
Primary	28	4,662	3.5
Secondary	43	11,418	8.5
Special	4	380	0.3
SCHOOL GENDER TYPE			
Co-educational	203	112,122	83.4
Female	16	12,830	9.5
Male	9	9,538	7.1
TYPE OF STUDENTS			
Boarding	36	3,885	2.9
Full Fee Paying Overseas	84	1,718	1.3
Distance Education	11	4,025	3.0
Indigenous	214	5,373	4.0
Disengaged Youth	26	2,946	2.2

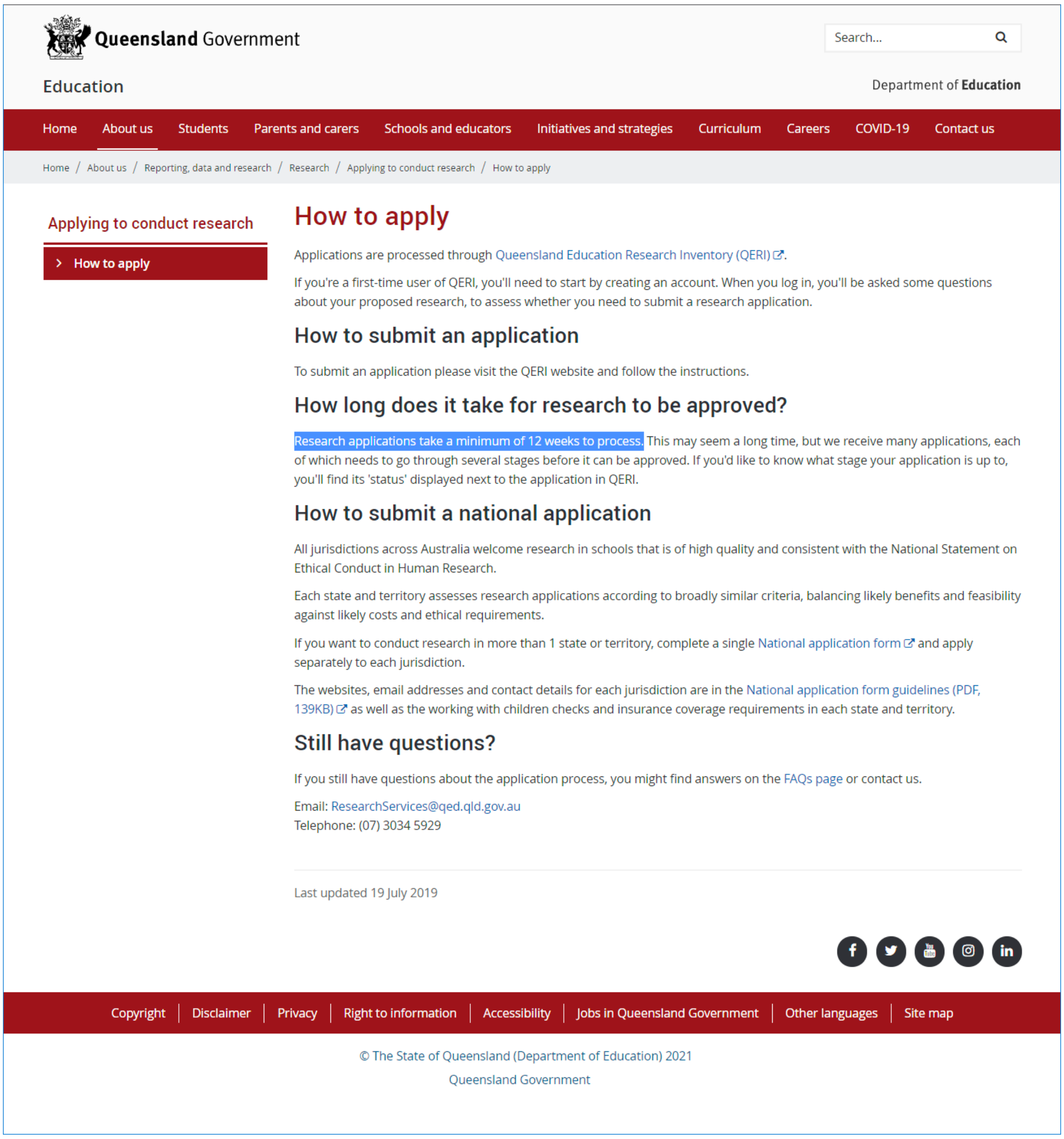
Source: 2020 Non-Government Schools Census (Commonwealth) August Collection.

Note: Data for one member school was not collected or reported in the Commonwealth Census, as this school is ineligible for Commonwealth funding. Data for this school was drawn from the 2020 Non-State Schools Census (State) February Collection.

Note. Figure E8 shows all Queensland Independent Member School Characteristics for all regions, and all genders, with results of 28 Primary Schools, and 153 Combined (Primary and Secondary) Schools. From Independent Schools Queensland 2020 Membership Report, 2021 (https://www.isq.qld.edu.au/media/opekjwmz/2020-membership-report.pdf).

Figure E9

Queensland Government Education Research in Schools



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Applying to conduct research

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How to apply

Applications are processed through Queensland Education Research Inventory (QERI).

If you're a first-time user of QERI, you'll need to start by creating an account. When you log in, you'll be asked some questions about your proposed research, to assess whether you need to submit a research application.

How to submit an application

To submit an application please visit the QERI website and follow the instructions.

How long does it take for research to be approved?

Research applications take a minimum of 12 weeks to process. This may seem a long time, but we receive many applications, each of which needs to go through several stages before it can be approved. If you'd like to know what stage your application is up to, you'll find its 'status' displayed next to the application in QERI.

How to submit a national application

All jurisdictions across Australia welcome research in schools that is of high quality and consistent with the National Statement on Ethical Conduct in Human Research.

Each state and territory assesses research applications according to broadly similar criteria, balancing likely benefits and feasibility against likely costs and ethical requirements.

If you want to conduct research in more than 1 state or territory, complete a single National application form and apply separately to each jurisdiction.

The websites, email addresses and contact details for each jurisdiction are in the National application form guidelines (PDF, 139KB) as well as the working with children checks and insurance coverage requirements in each state and territory.

Still have questions?

If you still have questions about the application process, you might find answers on the FAQs page or contact us.

Email: ResearchServices@qed.qld.gov.au
Telephone: (07) 3034 5929

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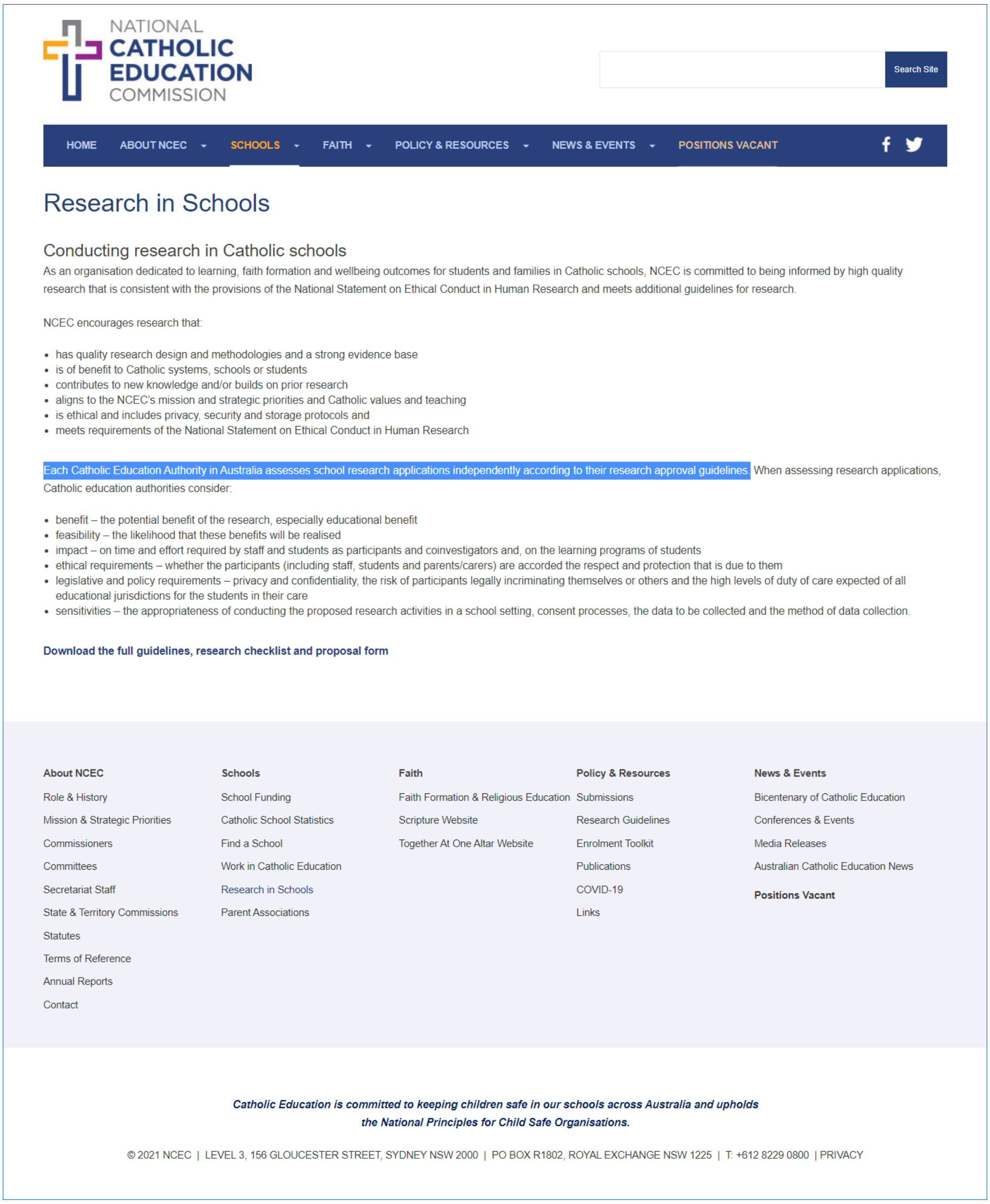
Queensland Government

Note. Figure E9 shows the directive from the Queensland Government for researchers approaching state schools. From Queensland Government, 2021 (https://education.qld.gov.au/about-us/reporting-data-research/research/applying-to-conduct-research/how-to-apply). © 2021 Queensland Government (Department of Education) 2021, all rights reserved.

Figure E10

National Catholic Education Commission Research in Schools



NATIONAL CATHOLIC EDUCATION COMMISSION

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Research in Schools

Conducting research in Catholic schools

As an organisation dedicated to learning, faith formation and wellbeing outcomes for students and families in Catholic schools, NCEC is committed to being informed by high quality research that is consistent with the provisions of the National Statement on Ethical Conduct in Human Research and meets additional guidelines for research.

NCEC encourages research that:

- has quality research design and methodologies and a strong evidence base
- is of benefit to Catholic systems, schools or students
- contributes to new knowledge and/or builds on prior research
- aligns to the NCEC's mission and strategic priorities and Catholic values and teaching
- is ethical and includes privacy, security and storage protocols and
- meets requirements of the National Statement on Ethical Conduct in Human Research

Each Catholic Education Authority in Australia assesses school research applications independently according to their research approval guidelines. When assessing research applications, Catholic education authorities consider:

- benefit – the potential benefit of the research, especially educational benefit
- feasibility – the likelihood that these benefits will be realised
- impact – on time and effort required by staff and students as participants and coinvestigators and, on the learning programs of students
- ethical requirements – whether the participants (including staff, students and parents/carers) are accorded the respect and protection that is due to them
- legislative and policy requirements – privacy and confidentiality, the risk of participants legally incriminating themselves or others and the high levels of duty of care expected of all educational jurisdictions for the students in their care
- sensitivities – the appropriateness of conducting the proposed research activities in a school setting, consent processes, the data to be collected and the method of data collection.

Download the full guidelines, research checklist and proposal form

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Catholic Education is committed to keeping children safe in our schools across Australia and upholds the National Principles for Child Safe Organisations.

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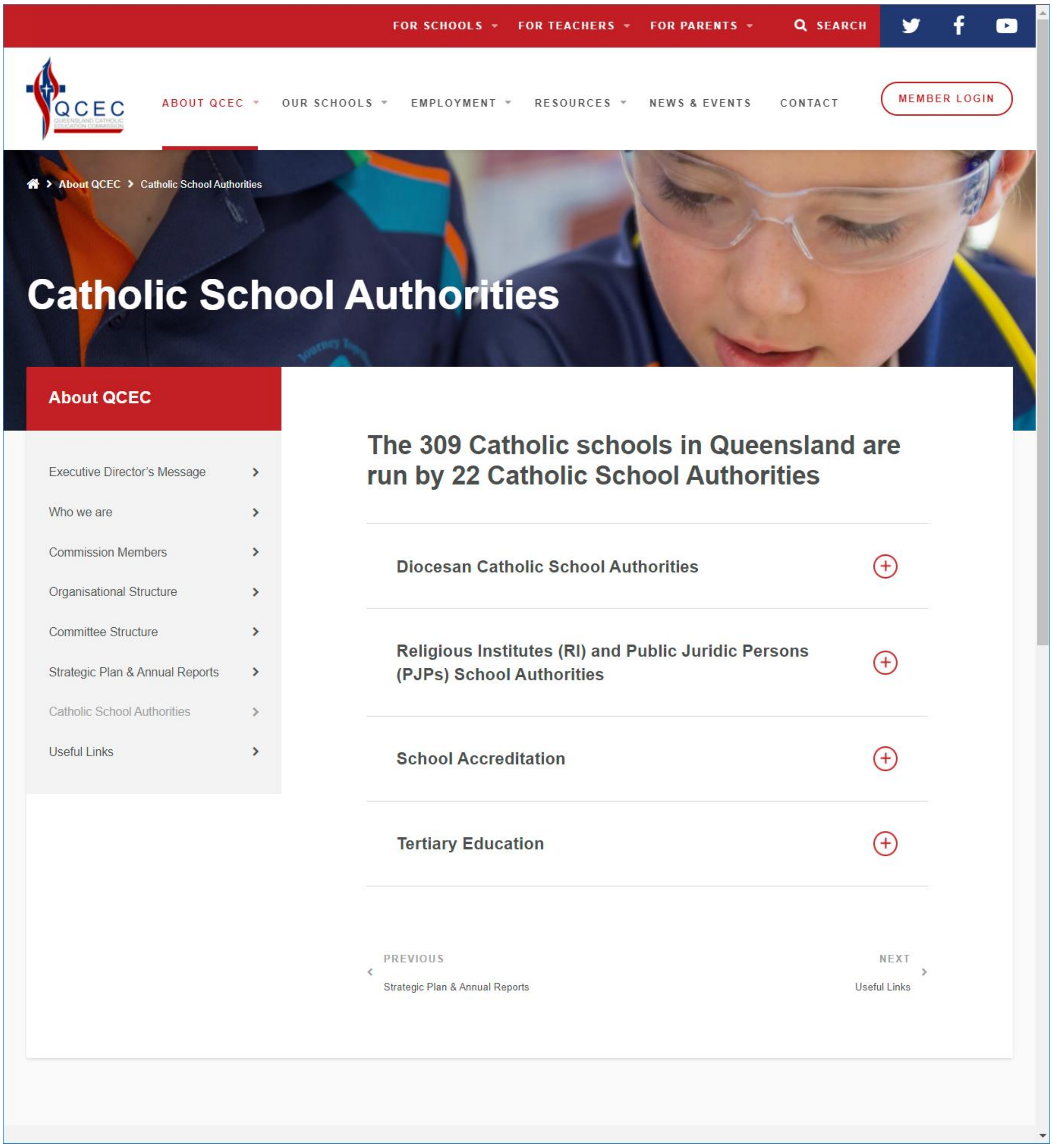
Note. Figure E10 shows the directive from the National Catholic Education Commission for researchers approaching member schools. From Australian Catholic Schools, 2021 (https://www.ncec.catholic.edu.au/schools/research-in-schools). © 2021 National Catholic Education Commission 2021, all rights reserved.

Figure E11

Queensland Catholic Education Commission School Authorities



Note. Figure E11 shows that the 309 Catholic Schools in Queensland are run by 22 Catholic School Authorities. From Queensland Catholic Education Commission, 2021 (https://qcec.catholic.edu.au/about-qcec/catholic-school-authorities/).

Figure E12

Independent Schools Australia

RU

Ruth Underwood <ruth.underwood@isa.edu.au>
Thu 8/19/2021 6:22 PM
To: Adrian McGrath

Hi Adrian

My apologies for the delay in responding to your email.

The circumstances are very similar for Independent schools in each state or territory - that the school Principal will need to decide whether they would like their teachers to participate in your interviews.

The majority of Independent schools operate as their own entity and are not part of a system that makes these decisions, so it is a matter of contacting schools individually.

Kind regards

RUTH UNDERWOOD
BUSINESS MANAGER

M +61 422 462 352
T +61 2 6282 3488
E RUTH.UNDERWOOD@ISA.EDU.AU

INDEPENDENT SCHOOLS AUSTRALIA

12 THESIGER COURT DEAKIN ACT 2600

WWW.ISA.EDU.AU
@INDSCHOOLSAUS

Note. Figure E11 shows an email received from the Business Manager at Independent Schools Australia confirming that a Principal is authorised to approve research at their school.

Appendix F

Codes, Code Summaries, & Themes

The tables in this Appendix are of each of the five themes and their supporting coding.

Table	Theme	Theme Name
Table F1	Theme 1	Teachers Defend the Curriculum.
Table F2	Theme 2	Learning Starts in the Classroom.
Table F3	Theme 3	A Teacher’s Individual Methods have to be Trusted
Table F4	Theme 4	Teachers Encourage Parent-Child Collaboration to Engage and Record Ability
Table F5	Theme 5	Teacher-Parent Collaboration has to Overcome Significant Disconnect to make Homework Functional

F.1 Theme 1: Teachers Defend the Curriculum

Theme 1: Teachers appreciate the Curriculum but grapple with it being either too generalised in some areas and too specific in others, and stress that without their training and experience parents are unable to fully understand and interpret it.

A homework system would therefore need to conduit the Curriculum for teachers' needs but operate in the background for parents.

1.1 Code Summary: Teacher Perspective of the Curriculum			
Teachers see the Curriculum as clear, concise, explicit in steps, and straightforward but not something parents should see.			
1.1.1	+	The Curriculum is clear, explicit and in steps.	0101
1.1.2	+	The Curriculum is a good curriculum and easy to follow.	0102
1.1.3	+	The Curriculum increments make it easy to differentiate so a teacher can create a unit plan around Year 2 and differentiate it down to Year 1.	0101
1.1.4	+	The maths part of the Curriculum is easier to navigate than the English part.	0101
1.1.5	+	The maths part of the Curriculum is straightforward and the 'Indicators' define what a student needs to do.	0201
1.1.6	-	The Curriculum is not something teachers would invite parents to look at.	0202
1.1.7	-	The Curriculum requires effort for parents to navigate.	0201
1.1.8	-	Teachers are unsure whether it is a good thing for parents to have access to the Curriculum.	0301
1.1.9	-	Teachers are trained to be able to navigate the Curriculum but can't easily print it for offline use or for parents because the links to the Elaborations click backwards.	0301
1.1.10	-	Teachers are unsure whether a parent would understand what everything means on the Curriculum especially Elaborations.	0301

1.2 Code Summary: Learning Objectives			
Teachers have to interpret through their training and experience what the actual learning objectives of the Curriculum are.			
1.2.1	-	Teachers have to manually connect Seesaw content to the Learning Objectives of the Curriculum.	0301

1.3 Code Summary: Strands - Proficiency Level Descriptions			
Teachers see the Proficiency Level Descriptions or Elaborations as not something parents should consume.			
1.3.1	-	The Level Descriptions or the Elaborations in the Curriculum are not something teachers expect to explain to parents.	0301

1.4 Code Summary: Strands - Content Descriptions			
Teachers can absorb the strands and the elaborations in the Curriculum into their teaching delivery, but as it is presented they would not use it to provide a sequential explanation to parents.			
1.4.1	+	The Elaborations in the Curriculum help teachers see what the students need to know and gives teachers ideas of how to deliver the content.	0101
1.4.2	+	The Curriculum allows a teacher to isolate every Year Level and expand its Strands.	0101
1.4.3	-	Teachers can't easily print the Curriculum on paper because the links to the Elaborations click backwards.	0301
1.4.4	-	The Level Descriptions or the Elaborations in the Curriculum are not something teachers expect to explain to parents.	0302
1.4.5	+	Number and Algebra**:** Teachers encourage parents to skip count, single-digit addition and subtraction.	
1.4.6	+	Number and Algebra: Manipulatives allow a student to demonstrate their construction of an answer through applying prior learned method, for example a student could turn an algebra problem round to make it into a subtraction problem.	
1.4.7	+	Number and Algebra: Some teachers like to see evidence that shows the student can write a number sentence, draw a picture, show their working, and provide an answer.	

1.4.8	-	Measurement and Geometry/Data and Graphs: Teachers find the amount of content required to be covered for Grade 1 in the Curriculum is heaps and does not account for the full range of learning needs, for example a student might not understand 'data and graphs' from one Strand but is now understanding 'shapes' from another Strand.	

1.5 Code Summary: Achievement Standards			
Teachers see the Curriculum's Achievement Standards to be too generalised, so they have to create comments that more specifically identify a student's true achievement.			
1.5.1	±	The Curriculum provides satisfactory, above satisfactory, and below satisfactory samples.	0301
1.5.2	-	Specific feedback to a parent of whatever their child is learning about would be better than the Achievement Standard levels: 'above satisfactory', 'satisfactory', 'below satisfactory'.	0202
1.5.3	-	Teachers need a bank of more specific feedback comments to choose from when marking homework instead of manually writing notes.	0202
1.5.4	-	The Achievement Standards in the Curriculum is a lot of writing when it would be clearer and concise with dot points.	0301

1.6 Code Summary: Work Sample Portfolio – Content			
Teachers find the amount of content required to be covered at Year 1 is heaps and the content provided on the Curriculum website as lacking, so they search the Internet for content.			
1.6.1	-	Teachers at independent schools don't use the content provided on the Australian Curriculum website.	0201
1.6.2	-	Teachers find the amount of content required to be covered for Grade 1 in the Curriculum is heaps and does not account for the full range of learning needs, for example a student might not understand 'data and graphs' from one Strand but is now understanding 'shapes' from another Strand.	0302

F.2 Theme 2: Learning Starts in the Classroom

Theme 2: Teachers see their classroom as the hub from where they can drive learning by mixing students with different abilities and formatively assessing them.

A collaborative homework system would therefore need to differentially and dynamically branch from the classroom learning through a private network to each home and to formatively inform back to the teacher.

2.1 Code Summary: Classroom Teaching			
The classroom is the focal hub for teachers to drive the education and for all parties to meet.			
2.1.1	+	Teachers can negotiate in the classroom with students who are having difficulty.	0102
2.1.2	+	Teachers can collaborate with parents in the classroom after school to teach parents concepts.	0102
2.1.3	+	Year 1 students need hands-on learning in the classroom.	0102
2.1.4	±	Year 1 maths in the classroom is dominated by Number understanding.	0101
2.1.5	±	Homework is based on what is being learned in the classroom.	0101
2.1.6	±	Homework is based off the classroom teaching plan following the Curriculum.	0301

2.2 Code Summary: Collaboration in the Classroom			
Collaboration between students is encouraged in the classroom whereas competition is not.			
2.2.1	+	Teachers promote collaboration and peer mentoring in the classroom by grouping students together with differing fluency levels especially when some students need more than one person to show them how to work a problem.	0101
2.2.2	-	Some teachers don't allow students to compete and compare themselves against their peers through measured learning.	0101
2.2.3	-	Inter-parent or inter-student knowledge of a student's performance position in their class is not valuable.	0201

2.2.4	-	Competition that identifies students in the classroom can work against the ones who score the lowest.	0301

2.3 Code Summary: Formative Assessment			
Teachers can apply formative assessment in the classroom.			
2.3.1	+	Extension Ability Groups are encouraged for intelligent students so they can formatively identify with their teacher aid the strategy or strategies they could apply to a problem.	0202
2.3.2	+	In the classroom teachers see the Evidence of a student's performance directly.	0102
2.3.3	+	Teachers are guaranteed diagnostics to be formative in the classroom and authentically the student's.	0101
2.3.4	+	Teachers can discover mathematical misconceptions in the classroom in a formative way and rectify them early.	0101

2.4 Code Summary: Summative Assessment			
A summative assessment of a student Is meaningful at report time and handover.			
2.4.1	±	Some teachers assess Summatively on paper at the start of term and then at the end of term.	0101
2.4.2	±	Teachers try to let parents know as soon as possible if their child is slipping behind rather than through a Summative Assessment at report time.	0101
2.4.3	±	Teaching mathematics is more about teaching process than getting a correct answer to a problem.	0101
2.4.4	±	Information about a student's Ability Level can be communicated to next year's teacher through a handover meeting.	0102
2.4.5	±	Some teachers provide summative feedback to parents at report time as an aggregated grade with general comments.	0201 0202

2.4.6	±	Teachers can discuss each individual student's major issues or strengths and show their work portfolio with samples of their work at handover meeting.	0201 0202
2.4.7	±	Teachers sometimes back-fill through observing students that have been handed-over to them.	0201 0202

2.5 Code Summary: Classroom Ability Groups			
Teachers can mix students with different ability in the classroom.			
2.5.1	+	Ability Groups can be 'mixed ability' where a creative thinker is grouped with a sequential thinker, or 'same ability'.	0101 0102
2.5.2	+	Students are unaware of differentiation in Ability Groups because the tasks are the same but what is required at that task is different.	0101

2.6 Code Summary: Classroom Apps

	School	**01**		**02**		**03**		**04**		
	Participant	**0101**	**0102**	**0201**	**0202**	**0301**	**0302**	**0401**	**0402**	
Classroom App	Seesaw					5	8			**Teacher Usage**
	Math-U-See	3	1							
	ClassDojo			1	1	1				
	Zoom		2				1			
	Blackboard	1								
	BrainPop Junior	1								
	Hit the Button						1			
	ictGames		1							
	Loom	1								
	MS Publisher	1								
	RoleM Maths		1							

2.7 Code Summary: Privacy			
Teachers are only starting to see the Privacy implications.			
2.7.1	±	Privacy is like an understanding with our parents	0101 0102
2.7.2	±	Teachers can use personal email and BCC to maintain privacy.	0102
2.7.3	±	A photo sent by a parent direct to the teacher of the work a student has done on an activity at home is private.	0102
2.7.4	±	Zoom feedback maintained privacy between teacher and parent.	0102
2.7.5	-	Teachers have to act precautionary and within school/parent guidelines to maintain privacy of photos of students and their identification.	0101
2.7.6	-	Teachers have to take precautions to maintain privacy so as not to publicly allow a student's identify be linked to their performance.	0202
2.7.7	-	Privacy is a concern if videos of our children are shared with parents from another school.	0302

2.8 Code Summary: Home-Class teaching During COVID Lockdowns			
Teachers were overworked preparing and managing Home-Class during lockdowns and were generally negative about the experience.			
2.8.1	+	During the COVID era some teachers telephoned parents to provide emotional and IT support.	0202
2.8.2	+	During the COVID era teachers would discuss with colleagues how to approach teaching concepts to parents.	0201 0202
2.8.3	+	During the COVID era parents gained an appreciation for the detail and professional structure teachers bring to their job.	0201
2.8.4	+	During the COVID era parents were often positive about learning and learning to teach the concepts themselves.	0201
2.8.5	+	During the COVID era parents appreciated the insight into how teaching is done, with some realising their own ability horizon, and others realising the value of parental support with homework.	0201

2.8.6	-	Setting homework during COVID-era added more difficulty to teachers because parents are busy.	0101
2.8.7	-	During the COVID era some teachers were overworked having to generate parallel content fit for home-class and also mark it, correct it, and provide feedback.	0202
2.8.8	-	During the COVID era some teachers were overwhelmed with the workload of coordinating two groups with the same content but delivered differently.	0201 0202
2.8.9	-	During the COVID era teachers were overworked trying to include face-to-face contact with children per subject so they would hear and see their teacher.	0202
2.8.10	-	During the COVID era teachers were overworked as they had to self-learn video production that took many 'takes' and hours of editing.	0202
2.8.11	-	During the COVID era teachers were overworked having to type up modified unit plans to be parent friendly.	0202
2.8.12	-	During the COVID era some teachers would have to discuss with parents of struggling students in a more personal way explaining how they teach concepts if the teacher's video wasn't fully understood.	0202
2.8.13	-	During the COVID era some teachers found it nerve-wracking to be video recorded presenting a class.	0202
2.8.14	-	During the COVID era some teachers were overwhelmed with trying to maintain teaching momentum using Zoom class.	0302
2.8.15	±	Teachers see learning from home as quite different to homework.	0201
2.8.16	±	During the COVID era Seesaw and Google Classroom were sometimes used as a form of communication with parents.	0302

F.3 Theme 3: A Teacher's Individual Methods have to be Trusted

Theme 3: Teachers' 'knowledge' of their students allows them to dynamically connect the student's individual goals to the Curriculum's learning objectives, differentially assign them to ability groups and formatively record and feedback to students and their parents.

A homework system would therefore have to adjunct to this process.

3.1 Code Summary: Ability Groups			
Teachers would prefer ability grouping to work undetectable by students in the background.			
3.1.1	✓	Content videos differentiated into Ability Groups would identify a student's position in class, generalised content videos don't.	0202
3.1.2	✓	Homework programs differentiated for individual students based on their needs and strengths would be good, but a lot of work to do.	0202
3.1.3	✓	A homework program should be able to provide a parent with a dynamic visual representation, based on Achievement Standards, of where their teacher wants them to formatively help their child.	0301 0302
3.1.4	+	Being Able to practice a level helps a teacher see that a student is capable of moving to the next Level.	0101
3.1.5	+	Teachers help students understand it's not what they know that is important but to look for the Next Challenge for something they don't know.	0101
3.1.6	+	Teachers encourage students to visualise where they could Advance To and the work involved to get there.	0101
3.1.7	+	A teacher's job is to help their students to know what the next goal is.	0101
3.1.8	-	Teachers are averse to telling a student they are in a certain Ability Group because of their lack of achievement.	0101
3.1.9	-	Class knowledge of a struggling student's Ability position in class can be detrimental to them so teachers rely on their judgement to extend and support them privately.	0201 0202
3.1.10	-	Teachers have limited time to produce content videos differentiated into Ability Groups.	0201 0202

3.1.11	-	Teachers have to manually differentiate a student's ability levels and stream them into either lower, mainstream, or extension Ability Groups for maths.	0301 0302
3.1.12	-	Student homework effort and/or parental encouragement do not always scale with Ability Levels.	0302
3.1.13	-	A range of Ability Levels at Year 1 is often due to a student not being able to read a maths question.	0301
3.1.14	±	Ability Grouping starts for a student where they come in at a certain level.	0101

3.2 Code Summary: Learning Objectives			
Teachers have to manually connect the Curriculum’s Learning objectives for a student’s individual goals and then report the student’s performance against them.			
3.2.1	✓	Technology does not provide understanding, fluency, problem-solving, and reasoning.	0101
3.2.2	✓	A homework program should provide parents with Learning Objectives linked to their child's strengths that form a report for the teacher to comment on.	0201 0202
3.2.3	✓	A homework program should measure a student's understanding, fluency and problem solving against Learning Objectives.	0301 0302
3.2.4	+	Teachers set Learning Goals with students so they know clearly where the teacher wants them to go to next.	0101
3.2.5	+	Some teachers provide Summative Feedback to parents at report time as an aggregated grade with general comments.	0201 0202
3.2.6	-	Teachers have to manually connect Seesaw content to the Learning Objectives of the Curriculum.	0301 0302
3.2.7	±	During the COVID era some teachers sent home a hard copy plan with the Learning Objectives and tasks required.	0201 0202

3.3 Code Summary: Evidence			
Evidence can be captured but storage methods have not been uniformly codified.			
3.3.1	✓	Video can be used as Evidence.	0102
3.3.2	✓	Photos can be used as Evidence.	0102
3.3.3	✓	There is no app that provides Evidence.	0101
3.3.4	✓	A homework program should retain digital Evidence of a task set by a teacher based on a Learning Objective that shows a student's progress/success and dynamically accrues that data to their report card.	0201 0202
3.3.5	-	Teachers would not rely solely on homework Evidence for reports.	0102

3.4 Code Summary: Extension			
Extension ability groups are to focus on more problem solving and strategy for more of the same but more difficult problems.			
3.4.1	✓	A homework program should allow teachers the option to provide a student an Additional Activity.	0202
3.4.2	✓	Teachers have to manually differentiate a student's ability levels and stream them into either lower, mainstream, or extension Ability Groups for maths.	0301
3.4.3	✓	A homework program should direct enquiring students to Explore deeper into an area rather than progressing further ahead of the teacher's plan.	0301 0302
3.4.4	+	Homework is an Extension of what is being taught in class.	0101
3.4.5	+	Teachers can ask parents to help their child to Practice at home something the child is focusing on or struggling with to reinforce it.	0101
3.4.6	+	In mathematics teachers broaden Extension work for ambitious students rather than advance their knowledge.	0101
3.4.7	+	Jazzed up students search for Extension work as a matter of course.	0101
3.4.8	+	All ability groups may work on the same concept, but Extension groups would focus more on problem solving and strategy with a teacher aid who will inform the teacher of the student's gaps.	0202

3.4.9	+	Extension Ability Groups are encouraged for intelligent students so they can formatively identify with their teacher aid the strategy or strategies they could apply to a problem.	0202
3.4.10	+	Extension tasks that require application of understanding to more of the same but more difficult problems is better to handover to the following year's teacher so the student has not over-progressed.	0301 0302
3.4.11	+	Colouring a section of homework is an Extension task.	0101
3.4.12	+	Year 1 students can be oblivious to the negative aspects of being identified to a particular Ability Group.	0201 0202
3.4.13	-	Class knowledge of a struggling student's ability position in class can be detrimental to them so teachers rely on their judgement to Extend and support them privately.	0201 0202
3.4.14	±	Literacy takes priority, Extension maths is optional.	0101

3.5 Code Summary: Reading-Literacy			
Literacy takes priority. A teacher's time is diluted when students can't read math problems.			
3.5.1	+	If students can read, they can interpret a Worded Problem in maths.	0101
3.5.2	+	Reading and Literacy means a child can read a mathematics problem freeing up the teacher to help another child who struggles to read.	0101 0102
3.5.3	-	If students can't Read they need a teacher besides them to read mathematics problems.	0101 0102
3.5.4	±	Literacy takes priority, extension maths is optional.	0101
3.5.5	±	Homework is a routine for students to continue practicing their Reading, Spelling, and Sight Words.	0101
3.5.6	±	The level of homework is sometimes based on the 'want' of parents. Sometimes it is better to send a book home to Read.	0301
3.5.7	**±**	**Mathematics has to be taught alongside Literacy.**	**0301**

3.6 Code Summary: Written Homework			
Written homework takes time to prepare but teachers see it as reliably a student's.			
3.6.1	+	Written homework is more reliably a student's because a teacher can see how whether a parent has over-contributed.	0302
3.6.2	-	Teachers are disappointed when students don't complete Written Homework that has been well prepared by the teacher.	0301 0302

3.7 Code Summary: Socioeconomic-Cultural			
Socioeconomic backgrounds can affect a student's access to technology.			
3.7.1	+	Teachers value students Interacting And Spending Time With Their Parents more than extra homework.	0301
3.7.2	-	Differing Socioeconomic backgrounds can affect a student's access to homework technology.	0301 0302

3.8 Code Summary: Homework Apps

	School	**01**		**02**		**03**		**04**		
	Participant	**0101**	**0102**	**0201**	**0202**	**0301**	**0302**	**0401**	**0402**	
Homework App	Email BCC	4	5		1					**Teacher Usage**
	Mathletics			1	4		2			
	School Website	4	2				1			
	Studyladder	2	2							
	Google Classroom	1				1	2			
	Google Slide	4								
	ictGames		3							
	Khan Academy	1	1							
	SmashMaths			2						
	Google Suite	1								
	Sunshine Online					1				
	PDF	1								

F.4 Theme 4: Teachers Encourage Parent-Child Collaboration to Engage and Record Ability

Theme 4: Teachers need hands-on proof of a student's ability before they trust extending them to a new Ability Group.

A homework system would therefore need to digitally store evidentiary proof of a student's hands-on manipulative homework contribution.

4.1 Code Summary: Collaboration			
Maths can be more suited to collaboration between parents and students.			
4.1.1	✓	It is possible that a digital collaborative homework system would still attract the same group of parents who collaborate through paper based homework.	0301 0302
4.1.2	+	Teachers can target maths homework to be more collaborative especially if parents see their child struggling.	0101 0102
4.1.3	+	Teachers can collaborate with parents in the classroom after school to teach parents concepts.	0101
4.1.4	+	Homework helps a student's understanding of maths through routines.	0201

4.2 Code Summary: Feedback			
Teachers seek to provide specific individualised feedback formatively to parents and students.			
4.2.1	✓	A homework program should allow parents to provide feedback on how their child worked at home on a task and for teachers to then feedback to the parent.	0201
4.2.2	✓	A homework program should numerically and visually isolate for a parent a student's achievement/ability at home that mirrors the tasks set in class to feedback and enable a parent to help their child formatively and retrospectively.	0202
4.2.3	✓	A homework program that formatively links to the Learning Objectives set by the teacher that identifies a student's ability (from their work at home) based on the Curriculum's Achievement Standards would save a teacher time and would allow them to select a judgement comment from a list that	0201

		could provide feedback/guidance to a parent on where they can specifically help their child.	
4.2.4	✓	A homework program should make it easy to feedback to a parent and student if they are doing well and offer them more challenging extension tasks.	0201 0202
4.2.5	+	Teacher can give individualised feedback to a student based on a photo submitted as evidence.	0102
4.2.6	+	Teachers can use email to send homework and feedback to parents.	0101
4.2.7	+	Individualised feedback is important for a student to read so that they can know in real-time what they know they can do and what is expected of them.	0101
4.2.8	+	Specific feedback to a parent of whatever their child is learning about would be better than the Achievement Standard levels: 'above satisfactory', 'satisfactory', 'below satisfactory'.	0201 0202
4.2.9	+	Teachers can follow up in class and give feedback to students based on videos they sent in of their homework.	0201 0202
4.2.10	-	Teachers face a massive task to allow parents to granularly see each week how their child has achieved on particular homework concepts.	0202
4.2.11	-	Teachers are mindful not to be too onerous when teaching parents who are very time-poor.	0202
4.2.12	-	Teachers need a bank of more specific feedback comments to choose from when marking homework instead of manually writing notes.	0201 0202
4.2.13	±	Some teachers provide summative feedback to parents at report time as an aggregated grade with general comments.	0201 0202
4.2.14	±	Teachers can provide feedback to students in class based on work the student completed at home on Seesaw.	0302
4.2.15	±	It is vital to feedback to parents as soon as a teacher becomes aware a student is struggling rather than leaving to report time.	0301 0302

4.3 Code Summary: Hands-On and Manipulatives			
Teachers see hands-on manipulative learning as superior to screen-based learning.			
4.3.1	+	Year 1 need Hands-On learning.	0102
4.3.2	+	Maths, especially in the lower levels, is a Hands-On process.	0101
4.3.3	+	Hands-On and manipulatives provide real-life experiences in maths homework and is superior to screen based learning.	0101
4.3.4	+	Students need a mix of Hands-On and technology, but they should primarily learn maths by actually 'doing' and handling materials.	0201
4.3.5	+	Homework should be: Hands-on, Manipulative, Touching, Feeling, Moving, Drawing.	0102
4.3.6	+	Manipulatives can be blocks, beads, fake money, calculators, whiteboards.	0101
4.3.7	+	Hands-on and Manipulatives provide real-life experiences in maths homework and is superior to screen-based learning.	0101
4.3.8	+	Manipulatives help students understand mathematics better because they enable them to see why maths happens.	0101
4.3.9	+	Manipulatives enable students to see there is more than one way to go about solving a mathematics problem.	0101
4.3.10	+	Manipulatives give students the experience of working out their own strategies.	0101
4.3.11	+	Manipulatives allow a teacher to see how a student is going about solving a problem.	0101
4.3.12	+	A teacher can take a photo of things for parents that demonstrates patterning with concrete resources, Manipulatives, and MAB blocks.	0201 0202
4.3.13	+	Teachers are now taught to implement STEM using Manipulatives such as plasticine and multimodal videos.	0302

4.4 Code Summary: Homework in Context			
Teachers drive homework from the classroom.			
4.4.1	+	Parents are encouraged to do incidental maths Homework.	0101
4.4.2	+	Colouring a section of Homework is an extension task.	0101
4.4.3	+	Homework is based on what is being learned in the classroom.	0101
4.4.4	+	Homework is an extension of what is being taught in class.	0101
4.4.5	+	Homework always relates to what is being done in class.	0102
4.4.6	+	Teachers can negotiate with students to use technology in Homework.	0102
4.4.7	+	Teachers can target maths Homework to be more collaborative especially if parents see their child struggling.	0101 0102
4.4.8	+	10-20 minutes of Homework is optimal. More than 20 minutes is too much.	0101
4.4.9	+	Teachers expect students to take charge of setting up Homework supervised by their parents.	0101
4.4.10	+	**Homework is a routine to continue practicing class work.**	0101
4.4.11	+	Some school/class websites offer links to Homework.	0101 0102
4.4.12	+	Homework helps a student's understanding of maths through routines.	0201
4.4.13	+	Homework is to help students understand the concepts being taught in class.	0201
4.4.14	+	Homework should be based on what is taught in class, so it is familiar, relatively easy, and not new.	0202
4.4.15	+	Homework is based off the teaching plan following the Curriculum.	0301
4.4.16	-	Homework is optional.	0101
4.4.17	-	Teachers don't want to be pushy with parents pushing Homework onto kids.	0101

4.4.18	-	Teachers don't know how much input parents contribute to a student's Homework.	0101
4.4.19	-	Some teachers are not fans of Homework when students have worked hard at school.	0201
4.4.20	-	The level of Homework is sometimes based on the 'want' of parents. Sometimes it is better to send a book home to read.	0301
4.4.21	±	The value of Homework should be balanced with going to the park with their parents.	0201
4.4.22	±	Year 1 maths is dominated by Number understanding.	0101

4.5 Code Summary: Incidental Maths			
Incidental maths at home teaches maths in context.			
4.5.1	+	Parents are encouraged to do Incidental maths while kids are in the bath or in the car.	0101
4.5.2	+	Parents can help students learn maths Incidentally while cooking dinner.	0101

4.6 Code Summary: Video-Photo			
Teachers regard student videos and photos as genuine evidence.			
4.6.1	+	Video can be used as evidence.	0102
4.6.2	+	Videos for parents to watch can help them understand the concepts the students are doing for homework.	0201
4.6.3	+	A student can repeat watching a Video until they understand a concept to help them do an extension task that the teacher has linked to Mathletics.	0202
4.6.4	+	A teacher can take a Photo of things for parents that demonstrates patterning with concrete resources, manipulatives and MAB blocks.	0201 0202
4.6.5	+	Students love to Video themselves as part of homework.	0201 0202

4.6.6	+	Teachers can follow up in class and give feedback to students based on Videos they sent in of their homework.	0201 0202
4.6.7	-	It is not practical for a teacher to Video themselves for all homework activities.	0201

F.5 Theme 5: Teacher-Parent Collaboration has to Overcome Significant Disconnect to make Homework Functional

Theme 5: Teachers are suspicious that parental contribution in traditional homework methods subverts the teacher's homework plan and the student's learning process, rendering any measurement of learning negotiable and a waste of time for all parties.

A collaborative homework system would therefore need to restore trust by empowering parents with time quantifiable consumable tasks that set up manipulative exercises that can measure a student's ability and inherently promote extension functionality.

5.1 Code Summary: Teachers Teaching Parents			
Teachers waste valuable teaching time having to teach parents.			
5.1.1	+	Teachers can use synchronous apps to teach a Parent one-on-one with examples to help them understand concepts.	0102
5.1.2	-	Parents often understand concepts but with different terminology.	0101
5.1.3	-	Teachers are mindful not to be too onerous when teaching Parents who are very time-poor.	0201
5.1.4	-	Teachers are frustrated and see it as harmful when Parents try to teach their children things other than what the child is expected to be doing and without any application to a maths problem, as it is often based on how the parent learned the concept.	0301
5.1.5	-	Some Parents want the teacher to teach to help with homework, while others want the Teacher to take care of the education.	0301 0302
5.1.6	±	During the COVID era Teachers would discuss with colleagues how to approach teaching concepts to Parents.	0201 0202

5.1.7	±	Teachers often offer open-nights at the year's commencement to address all Parents together as to how they will conduct their teaching for the year.	0301 0302

5.2 Code Summary: Parental Collaboration			
Teachers distrust parental collaboration.			
5.2.1	+	Teachers encourage parents to skip count, single-digit addition and subtraction.	0101
5.2.2	+	**Parents are encouraged to do incidental maths while Kids are in the bath or in the car.**	0101
5.2.3	+	Parents can set drills at home based on drills in the classroom.	0101
5.2.4	+	Teachers can target maths homework to be more collaborative especially if Parents see their Child struggling.	0101 0102
5.2.5	+	Teachers can use synchronous apps to teach a parent one-on-one with examples to help them understand concepts.	0102
5.2.6	+	Parents are keen to learn.	0102
5.2.7	+	Teachers expect students to take charge of setting up homework supervised by their parents.	0101
5.2.8	+	Some Teachers see Parental involvement in homework as a bonus.	0101
5.2.9	+	Teachers can ask Parents to help their child to practice at home something the Child is focusing on or struggling with to reinforce it.	0101
5.2.10	+	Videos for Parents to watch can help them understand the concepts the Students are doing for homework.	0201 0202
5.2.11	+	Teachers often have to find ways to help Parents so that they are supporting what the Teacher does.	0201
5.2.12	+	Homework helps a Student's understanding of maths through routines.	0201
5.2.13	+	Teachers value students interacting and spending time with their parents more than extra homework.	0301

5.2.14	-	Setting homework during COVID-era added more difficulty to Teachers because Parents are busy.	0101
5.2.15	-	Parents are not responsible for looking into the Curriculum or finding out what their Kids should be using.	0101
5.2.16	-	Teachers try to keep homework from being onerous and time demanding of the Parent and Student.	0101
5.2.17	-	Teachers often see Parental collaboration as problematic when Parents don't understand the concepts themselves.	0102
5.2.18	-	Teachers don't want to be pushy with parents pushing homework onto kids.	0101
5.2.19	-	Teachers don't know how much input parents contribute to a Student's homework.	0101
5.2.20	-	A Child may get everything right in homework but teachers don't know how much assistance they've had.	0102
5.2.21	-	Some Parents might not know what their children need to do for homework.	0201
5.2.22	-	Parents sometimes will try and help but without understanding how it is being taught by the Teacher and potentially undoing what has been taught to the Student.	0201
5.2.23	-	Teachers lack absolute trust that a student's parent has not overcontributed to their homework.	0202
5.2.24	-	Teachers face a massive task to allow parents to granularly see each week how their child has achieved on particular homework concepts.	0202
5.2.25	-	Teachers who work overtime helping parents with ways to support their child at home can be dismayed when the parent then fails to make time to take the action.	0201 0202
5.2.26	-	Teachers are frustrated and see it as harmful when parents try to teach their children things other than what the child is expected to be doing and without any application to a maths problem, as it is often based on how the parent learned the concept.	0301

5.2.27	-	Student homework effort and/or parental encouragement do not always scale with ability levels.	0302
5.2.28	-	Some parents want the teacher to teach to help with homework, while others want the teacher to take care of the education.	0301 0302
5.2.29	-	Teachers are disappointed when students don't complete homework that has been well prepared by the teacher.	0301 0302
5.2.30	-	Teachers are suspicious of screen-based homework technology because they can't see the student's personal evidence, or how long the student has sat in front of the screen, or tell whether the parent has overcontributed.	0301 0302
5.2.31	-	It is vital to feedback to parents as soon as a teacher becomes aware a student is struggling rather than leaving to report time.	0301 0302
5.2.32	-	Teachers expect parents to have faith in their understanding of the Curriculum.	0301 0302
5.2.33	±	Parents usually form friendships with each other at Year 1 and can use Facebook groups to communicate to each other.	0101 0102
5.2.34	±	Teachers can use email to inform Parents that the class website has been updated.	0102
5.2.35	±	Email is a convenient way for Teachers to communicate to Parents.	0101 0102
5.2.36	±	A photo sent by a Parent direct to the Teacher of the work a Student has done on an activity at home is private.	0102

5.3 Code Summary: Time			
Teachers and parents don’t want to waste time on homework if they don’t believe it works.			
5.3.1	-	Setting homework during COVID-era added more difficulty to teachers because parents are busy.	0101
5.3.2	**-**	**Teachers try to keep homework from being onerous and time demanding of the parent and student.**	**0101**

5.3.3	**-**	**Teachers who work overtime helping parents with ways to support their child at home can be dismayed when the parent then fails to make time to take the action.**	**0201** **0202**

Appendix G

Limitations to Finding a Participant Sample

Introduction

This Appendix outlines the problems and issues that arose within the backdrop of the COVID19 pandemic to identify potential schools to approach in Queensland in Section G.1. The reasoning for choosing Independent Schools in Queensland is in Section G.2. How the Researcher approached independent schools through personal contacts and emails direct to their school principals in Section G.3, and direct to teachers through Facebook groups in Section G.4.

G.1 Identifying Potential Schools to Approach

The Researcher originally intended to target a mix of schools both state and non-state and interview each individual teacher in their classroom after school hours for thirty minutes. However, in early 2020 the International Committee on Taxonomy of Viruses (ICTV) announced “severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)” as the name of the virus commonly referred to as COVID19 (Nature Microbiology, 2020). ICTV chose this name because the virus is genetically related to the virus responsible for the SARS outbreak of 2003, which was also a coronavirus, however while related, the two viruses are different (World Health Organization, 2021). 2020 saw a worldwide acceleration of cases, deaths, and a public health crisis relating to how to treat cases, prevent hospital overcrowding, protect health-workers, and manage economies with lockdowns until a vaccine became available.

Despite the prevalence of the COVID19 pandemic and approaching Delta variant that had entered Australia during 2021 Queensland had remained relatively unscathed from mass outbreaks, with in-public mask mandates, home-quarantining, QR-code use, contact tracing, phone-app location tracking, easy access to testing, and state-mandated quarantining for travellers from COVID19 hotspots all being applied to mitigate full lockdowns. Australia had also secured a range of vaccines from different providers that became available in the second quarter of 2021 for aged residents and those with co-morbidities categorised at high-risk of hospitalisation if infected (fortunately the Researcher, was categorised for early vaccination through being immunosuppressed from rheumatological biological immunotherapy). For these reasons the Researcher narrowed the target range of schools to be within Queensland as travel to other states could result in a 14-day state-mandated quarantine that would cost the Researcher $2,800 (Queensland Government, 2021a). As a result, the Researcher requested an amendment to the University Ethics application to include ZOOM online video interviews as well as in-person interviews in case a government lockdown was ordered.

Ethical considerations when approaching a teacher or a school were to be observed. In Australia a teacher who is employed at a school is not able to participate in academic research as a respondent without approval from their employer. This is similar to how non-disclosure agreements are fundamentally included in most employment contracts in the private sector. In the case of teachers their employer will either be the state or a private school. The Researcher therefore had to navigate the easiest route to find willing participants given the limitations and constraints of this process, and the pandemic. The following sequence of target reduction explains how the Researcher whittled down quite a large target group of schools to approach a relatively small number of potential candidate schools. However, willing participants from within the eventual cohort of schools still had to volunteer. The following explanation of sample defining also is backed up by screenshots of the Queensland Government website and other school body websites as of October 2021. This is done to provide evidence as the numbers of schools may change over time.

Table G1 shows the spread of 2,778 schools and educational centres in Queensland. The Researcher narrowed this focus to 1,254 state school groups (45%) and 540 non-state school groups (19%) as together they contained the majority (1,794) making up 64% (45% plus 19%) of all schools and educational centres most likely to contain the targeted sample of participants being primary school teachers.

Table G1

Table of Queensland Schools and Education Centres

Queensland Schools and Educational Centres	**Number**	**Target**	**%**
Associated Facility	55		
Associated Facility - Special Assistance School	4		
Associated Unit (Other)	4		
Campus	50		
Centre for Continuing Secondary Education	4		
Intensive English Centre	23		
Non State School Distance Education	10		
Non-State School	540	540	19%
Outdoor and Environmental Education Centre	24		
Positive Learning Centre	15		
Special Campus	1		
Special Education Program	740		
Sport Education Centre	1		
State School	1,254	1,254	45%
Student Residential	3		
Support Unit (Other)	49		
Total	**2,778**	**1,794**	**64%**

Note. All Queensland Schools and Education Centres. From “Department of Education Schools Directory” Queensland Government. (2021b).

Table G2 shows the types of the 1,794 state and non-state schools in Queensland. Of the 1,794 total of state and non-state schools 1,254 are state schools (70%) and 540 are non-state schools (30%). It was intended at the outset that these schools would be the initial schools to approach for participants given that together they had a smaller lot of governing bodies to contact and easier geographical access to consider for in-person interviews.

Table G2

Table of Queensland State and Non-State School Types

Queensland State and Non-State School Type	Number	%
State	1,254	70%
Non-State	540	30%
Total	**1,794**	**100%**

Note. Queensland State and Non-State School Types. From "*Department of Education Schools Directory"* Queensland Government. (2021b).

Table G3 shows the characteristics of the 1,254 Primary, Secondary, Combined (Primary and Secondary), and Special state schools in Queensland. Of the 1,254 state schools only 922 primary schools (74%) and 93 Combined (Primary and Secondary) schools (7%) totalling 1,015 (81%) would be suitable as they contained the targeted primary schools.

Table G3

Table of Queensland State School Characteristics

Queensland State School Type	Number	Target	%
Primary	922	922	74%
Secondary	194		
Combined (Primary & Secondary)	93	93	7%
Special	45		
Total	**1,254**	**1,015**	**81%**

Note. Queensland State Schools, Appendix E, Figure E4 *Queensland State Primary Schools*, and Appendix E, Figure E5 *Queensland State Combined (Primary & Secondary) Schools*. From "*Department of Education Schools Directory"* Queensland Government. (2021b).

The other schools that would be suitable included Queensland non-state schools. These schools are either Catholic Schools or Independent Schools. Table G4 shows the types of the 540 Queensland non-state schools with 312 Catholic Schools (58%) and 228 Independent Schools (42%).

Table G4

Table of Queensland Non-State School Type

Queensland Non-State School Type	Number	%
Catholic	312 *	58%
Independent	228	42%
Total	**540**	**100%**

Note. Queensland Non-State School Types. From "*Department of Education Schools Directory"* Queensland Government. (2021b). * The data discrepancy relates to the publication date for Queensland Catholic Member School. From Australian Catholic Schools, 2019.

Table G5 shows the characteristics of the 312 Primary, Secondary, Combined (Primary and Secondary), and Special Catholic schools in Queensland. Of the 312 Catholic member schools only 196 Primary schools (63%) and 33 Combined (Primary and Secondary) schools (11%) totalling 229 (74%) would be suitable as they contained the targeted primary schools.

Table G5

Table of Queensland Catholic Member School Characteristics

Catholic Member School Characteristics	Number	Target	%
Primary	196	196	63%
Secondary	75		
Combined (Primary & Secondary)	33	33	11%
Special	-		-
Total	**312** *	**229** *	**74%** *

Note. Queensland Catholic Member School Characteristics. From "Australian Catholic Schools, 2019 *"* National Catholic Education Commission 2019. * The data discrepancy relates to the publication date for Queensland Catholic Member School. From Australian Catholic Schools, 2019.

Table G6 shows the characteristics of the 228 Primary, Secondary, Combined (Primary and Secondary), and Special Independent schools in Queensland. Of the 228 Independent member schools only 28 Primary schools (12%) and 153 Combined (Primary and Secondary) schools (67%) totalling 181 (79%) would be suitable as they contained the targeted primary schools.

Table G6

Table of Queensland Independent Member School Characteristics

Independent Member School Characteristics	Number	Target	%
Primary	28	28	12%
Secondary	43		
Combined (Primary & Secondary)	153	153	67%
Special	4		
Total	**228 ***	**181**	**79%**

Note. Queensland Independent Member School Characteristics. From "*Independent Schools Queensland 2020 Membership Report, 2021"* Independent Schools Queensland 2021.

G.2 Choosing Independent Schools

On closer examination the Researcher found that the approval process to receive permission from the Queensland State Government Department of Education to approach state schools requires a separate application to be submitted with an average wait time of 12 weeks during which time additional information may be required to provide more information to support the decision-making process during the review period (Queensland Government, 2018). The state jurisdiction assesses research applications according to broadly similar criteria, balancing likely benefits and feasibility against likely costs and ethical requirements (Queensland Government, 2018). See Appendix E, Figure E9.

The Catholic schools governing body in Australia the National Catholic Education Commission advise that:

> Each Catholic Education Authority in Australia assesses school research applications independently according to their research approval guidelines. (See Appendix E, Figure E10.)

Further investigation revealed that the Catholic school education governing body in Queensland, The Queensland Catholic Education Commission, has 22 Catholic school education authorities. See Appendix E, Figure E11. The Researcher approached Independent Schools Australia and received confirmation from their Business Manager that:

> The circumstances are very similar for Independent schools in each state or territory – that the School Principal will need to decide whether they would like their teachers to participate in your interviews. The majority of Independent schools operate as their own entity and are not part of a system that makes these decisions, so it is a matter of contacting schools individually. (See Appendix E, Figure E12).

Independent schools have been operating in Australia for over 150 years providing educational services to students representing over 12% of Queensland's school enrolments. Independent schools offer parents choices in the education of their children that are not available in state schools. They offer families the opportunity to select schools that they believe best serve their child's needs and promote the values they believe are important. In general Independent schools offer:

- High educational standards
- Moral and spiritual values
- Pastoral care and discipline
- Programs to meet the needs and interests of individual students
- Strong home-school partnerships
- A wide variety of extra and co-curricular activities

Table G7 shows the spread of gender types in Queensland Independent Schools Queensland: Co-educational, Female, and Male.

Table G7

Queensland Independent Member School Gender Type

Independent Member School Gender Type	**Number**
Co-educational	203
Female	16
Male	9
Total	**228**

Note. Table G7 is from Independent Schools Queensland, 2020a.

Table G8 shows the spread of the different affiliations for member schools of Independent Schools Queensland.

Table G8

Queensland Independent Member School Affiliation

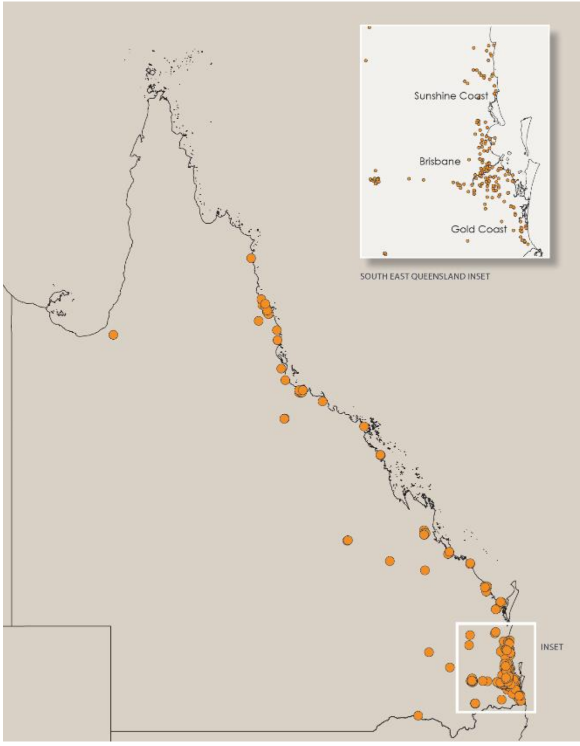
Independent Member School Affiliation	Number
Ananda Marga	1
Anglican	**12** *
Assemblies of God	10
Baptist	7
Brethren	1
Catholic (Other)	1
Christian	**43** *
Grammar	8
Inter-Denominational	5
Islamic	2
Jewish	1
Montessori	4
Non-Denominational	36
Other	27
Other Religious Affiliation	1
Pentecostal	2
PMSA	4
Presbyterian	1
Steiner	5
Uniting Church	5
Anglican Schools Commission	11
Lutheran System Commission	**26** *
Seventh Day Adventist - Northern Australia	3
Seventh Day Adventist - South Queensland	7
Queensland Religious Institute	5
Total	**228** *

Note. Table G8 is from Independent Schools Queensland, 2020a.

Figure G1 shows the spread of Independent schools across Queensland.

Figure G1

Spread of Independent Schools across Queensland



Note. From "*Independent Schools Queensland 2020 Membership Report, 2021"* (page 7). Independent Schools Queensland 2021.

G.3 Approaching Independent Schools through Emails to Principals

The Researcher contacted Independent Schools Queensland and received access to a Comma Separated Value (.csv) file that listed all independent schools in raw data format (see Figure G2).

Figure G2

Raw Data of Independent Schools in Comma Separated Value Format

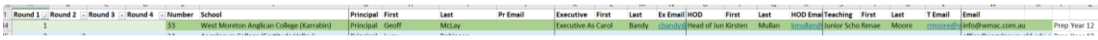
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	Centre Co	Centre Na	Centre Ty	Centre Sta	Host Cent	Host Cent	Official Lo	Official Hi	Officer In	Internet S	Phone Nu	Fax Numb	Actual Ad	Actual Ad	Actual Ad	Actual Ad
2	5817	A B Paters	Non-State	Open			Prep Year	Year 12	Principal	www.abp	(07) 5594	(07) 5594 7650		10 A B Pat	Arundel	4214

	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	
1	Postal Ad	Postal Ad	Postal Ad	Postal Ad	Education	Federal El	State Elec	Local Gov	Statistical	Statistical	Remotene	Enrolmen	All Studer	ABN	Sector	Non-State	Lo
2	10 A B Pat	Arundel		4214	South Eas	Fadden	Bonney	Gold Coas	Arundel	3.09E+08	Major Cities of Australia				Non-State	Independ	1

The Researcher sorted the '.csv' file into a Microsoft Excel spreadsheet to identify Primary and Combined/Co-ed from the raw data to exclude 'secondary only'. This created a sample of 120 qualified schools out of 228 Independent schools. The spreadsheet was further sorted and ordered identifying each school which was then linked to a Microsoft Word document that prepared individual emails to each Principal to be sent in one of four tranches (see Figure G3).

Figure G3

Sorted Data Prepared to Send Emails to Principals



Round 1	Round 2	Round 3	Round 4	Number	School	Principal	First	Last	Pr Email	Executive	First	Last	Ex Email	HOD	First	Last	HOD Emai	Teaching	First	Last	T Email	Email		
1				33	West Moreton Anglican College (Karrabin)	Principal	Geoff	McLay		Executive As	Carol	Bandy	cbandy@	Head of Jun	Kirsten	Mullan	kmullan@	Junior Scho	Renae	Moore	rmoore@w	info@wmac.com.au	Prep	Year 12

Formal invitation emails were sent to each principal identifying the Researcher, the project title, the criteria for candidate participant teachers, the time required (30 minutes), and an offer of a $25 gift token to recognise each teacher's time to participate. Nine school principals responded through email providing the following approval:

> Principal approval is granted for teacher participation in this study if they choose.

Those principals sent the invitation through their school's internal email system to the potential candidate primary teachers who had taught Year 1 within the last 3 years. Two schools with two qualified teachers in each school responded for a total of four qualified teachers who met the Inclusion Criteria. All communications were documented through the Researcher's USQ email address, the principal's email address, and the respondent teacher's email address. Respondent teachers were provided the following documents and agreeable respondent teachers provided the Researcher their signed consent form:

- Participant Consent Form Interview.pdf
- Participant Interview Questions.pdf
- Participant Information Document.pdf

G.4 Approaching Independent School Teachers through Facebook

The Researcher also ran a Facebook advertisement by enrolling on nineteen Facebook teacher sites. Figure G4 shows the USQ University Ethics Department approved flyer advertisement.

Figure G4

University of Southern Queensland Approved Flyer Advert

Table G9 documents the Queensland Facebook groups the Researcher ran the ad through.

Table G9

Facebook Groups Advertisement Results

	State	Facebook Group
1	**Queensland**	Primary Teachers Queensland
2		**QLD Primary School Teachers**
3		QLD Teachers
4		Early Childhood Teachers in
5		Queensland Relief Teachers
6		Townsville

Following a poor response from the ad that ran on Queensland Facebook groups the Researcher started the analysis with the interviews already conducted from Independent schools in Queensland. During the analysis the Researcher ran the ad on NSW and other Australia wide Facebook groups. It is to be noted that at this time the country was going through a range of lockdowns and the teachers from some whole districts were working the classes of students over Zoom at home. Table G10 shows the NSW and Australia wide Facebook groups the Researcher ran the ad through.

Table G10

Facebook Groups Advertisement Results

	State	Facebook Group
7	NSW	NSW Primary Teachers
8		NSW Casual Teachers
9		NSW Stage 1 Teachers
10		Teachers in NSW – Western Suburbs
11	Australia	Australian Primary Teachers
12		Year 2 Teachers in Australia
13		Year2/3 Teachers Australia
14		Australian Prep Teachers
15		Beginning Teachers Resource Forum
16		Casual Relief Teachers
17		Teacher's Aide Australia
18		Australian Teachers – Buy, Swap and
19		Teachers in Remote Communities

The Researcher received ten responses to the Facebook ad from teachers at Queensland State schools, twelve from teachers at Non-Queensland State schools, three from teachers at Independent schools who did not receive principle approval, and one NSW teacher who had just finished employment before a long-term lockdown. Table G11 shows this in tabularised form.

Table G11

Response Exclusion

Respondents	Facebook
Queensland State School	**10**
Non-Queensland State School	**12**
Queensland Independent School No Principal	3
NSW - Not currently employed	**1**
TOTAL	**26**