Mathseeds White Paper

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ABC Mathseeds

Contents

Executive Summary

Mathseeds is an innovative teaching and learning program that focuses on the needs of students learning mathematics in Kindergarten to Year 3. The program has been carefully structured to support individual learning by combining pedagogical research on number sense; child development; technology; motivation; and key curriculum initiatives. Taking into consideration the needs, learning styles and future direction of learners in the 21st century, *Mathseeds* combines a highly motivational play-based online context with structured sequential mathematical lessons. At the core it is a teaching and learning sequence consisting of 150+ lessons where key concepts in mathematics are taught, explored, practised and assessed. Alongside the core lessons are fluency and assessment components, as well as rewards and a range of teacher resources to guide students towards their most successful mathematical future. It seamlessly connects learning between school and home across a range of computer devices. Teachers are able to monitor and report on both whole class and individual student progress, and provide useful feedback to students, parents and other key stakeholders in their schools. *Mathseeds* is carefully designed to motivate and maximise student learning to provide the strongest foundation to achieve lifelong mathematical success.

National Climate

Sullivan (2011) in his research looked at the goals of school mathematics in first defining what we expect from mathematics programs in our schools. His research pointed to Australian practice as focused on giving "practical and useable mathematics" to children throughout their formal years of schooling. Ernest (2010) was explicit in his description of the two perspectives of mathematics, the *practical* perspective and the *specialised* perspective. Both perspectives are important in classroom pedagogy to ensure students receive the skills and content (practical) as well as the understanding (specialised) to use mathematics flexibly throughout their lives.

In its comprehensive design, the Australian Curriculum was built upon two dimensions to explore both perspectives: the content strands and the proficiencies. The content strands detail the mathematical concepts to be explored and the proficiencies look at "how content is explored or developed, that is, the thinking and doing of mathematics" and "the actions in which students can engage when learning and using the content" (ACARA, 2015). The proficiencies set this curriculum apart by linking content to the thoughtful action and active exploration by students at all levels of competency. In developing a national curriculum in this way ACARA has established a balanced and strong framework that aims to be flexible in order to challenge students in exploring mathematics.

In-depth analysis of mathematics and science retention rates in senior years of schooling has seen a steady, slow decline in Australia with figures that are reiterated in developed nations around the world (Kennedy, Lyons and Quinn, 2014, p.35). Increasingly students are opting for non-Calculus based mathematics courses propelling a downward trend in intermediate and advanced calculus based mathematics during senior years.

There are a plethora of reasons for this decline including self-efficacy in the subject, perceptions of difficulty but also usefulness, prior achievement in mathematics, alongside the rate of interest and enjoyment derived from mathematics (Department of Education, 2015). The difficulty for teachers and school administrators is to build up the profile of mathematics not only for the immediate need of university entrance requirements (which can dictate senior student choices) but also for "future aspirations" (Kennedy, Lyons and Quinn, 2014, p.45).

Schools need to make learning interesting and relevant to actively engage students (Stephens, 2011). This begins in the early years of learning. Research by leading scientists Prinsley & Johnston (2015) discusses the importance of transforming STEM education in primary schools. *Mathseeds* offers teachers an engaging, well-structured program designed to motivate students to want to learn mathematics. By positioning mathematics as a highly interactive tool for problem solving and reasoning, mathematics becomes part of how students think and experience success. The program demands a high achievement in mathematics learning in line with the Australian Government's determination to make mathematics a priority in schools (Prinsley & Johnston, 2015). In the early years of STEM education ~~it is~~ student engagement and skill growth sets a trajectory for sustaining higher levels of achievement in mathematics.

"There is a strong emphasis on the need to capitalise on number sense in the early years of schooling, and teachers are encouraged to provide children with experiences that will develop number sense and thus improve mathematics outcomes."

Dr Sally Clare Howell and Dr Coral Rae Kemp, Macquarie University Special Education Centre, 2010

Number Sense

Children develop their mathematical abilities following natural learning progressions with number sense being a formative platform for numeracy success (Clements & Sarama, 2009; Klibanoff, Levine, Huttenlocher, Vasilyeva & Hedges, 2006). Broadly, number sense is the "understanding of number needed by children if they are to succeed in mathematics" (Howell & Kemp, 2006). It encapsulates counting abilities; number patterns; estimation; sequencing; connecting counting to cardinality; and number manipulation.

In their research, Cain, Doggett, Faulkner & Hale (2007) outline seven key components that are core to number sense. *Figure 1* shows these components: quantity/magnitude; numeration; equality; base ten; form of a number; proportional reasoning; algebraic and geometric thinking. Faulkner (2009) asserts that ultimately these components of number sense operate as a useful framework in visualising the interconnectedness of the principles of mathematics. It is important to view this not as a progressive model but rather as each component is connecting and therefore integral to each lesson.

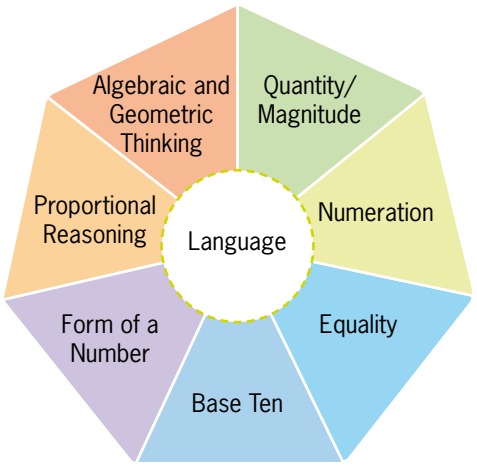

Figure 1: Cain and colleagues (2007) identified seven core components of number sense.

Strong number sense has been shown as a precursor of future mathematical success (Jordan, Kaplan, Locuniak & Ramineni, 2007) with the suggestion it may prove to be to mathematics what phonemic awareness is to reading (Gersten & Chard, 1999). To help nurture the natural learning progress of number sense, students need to explore numbers and engage with them using multiple presentations and a wide variety of different activity types.

Mathseeds recognises the importance of number sense and the strong developmental role it has for setting the most successful trajectory in mathematics. It situates number sense activities in scenarios that are familiar such as playgrounds, kitchens for cooking and shopping adventures. In doing this *Mathseeds* provides a playful environment to explore and interpret the quantitative concepts of number sense. This playful format also allows for number sense concepts to be presented and explored by students in a variety of ways. The sequence of lessons in *Mathseeds* supports children by continually revisiting concepts and building on earlier skills in a way that deepens their understanding. This provides a strong foundation for more complex mathematical processes to come.

Program Features

Key Elements

Research has indicated that several principles and critical factors underpin the most effective mathematical pedagogy and instruction. These principles include motivation and engagement; building on students' thinking; making connections; structured lessons; tools and representations; feedback; and assessment for learning (Anthony, & Walshaw, 2009; Jensen, 2005; Sullivan, 2011). *Mathseeds* combines each of these into an engaging environment for young children. The program focuses on student interaction and features a wide variety of short instructional movies and highly motivating activities. Students continually earn rewards which encourages active participation.

All *Mathseeds* lessons follow a similar structure. Each lesson focuses on a particular mathematical competency, with instructional lessons being taught by one of the five key characters. The program offers students opportunities to engage in practise and review activities, with up to 12 parts. Initial lessons build on the students' early mathematical experiences and focus on developing number sense. Other lessons focus on operations and algebra, geometry, measurement and data.

Mathseeds Lesson 14 has 12 instructional parts and activities. The lesson introduces the number eight. It has as a strong instructional focus on the early skill of one-to-one correspondence which is an important prerequisite to rational counting (Rays, Lindquist, Lambdin & Smith, 2012). *Figure 2* shows this teaching activity in action. Mango the monkey and Silky the spider help children identify the number eight visually and by name. Various activities follow that reinforce the number's name and shape, and students identify number eight both in isolation and when presented as one of three other numbers. Students count one item at a time to reinforce the concept of cardinality. *Figure 3* shows this teaching activity in action.

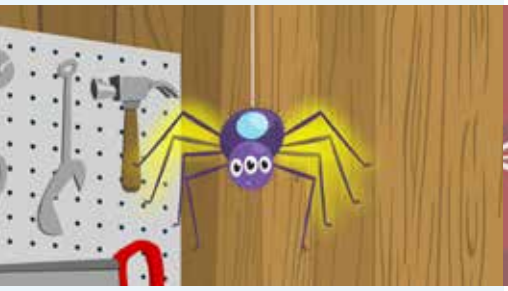

Figure 2: *Lesson 14,* narrator is guiding student through one-to-one correspondence.

Figure 3: *Lesson 14*, narrator is guiding student through counting to demonstrate cardinality.

After the initial lesson animations, Lesson 14 continues with a variety of interactive activities that focus on number identification, number formation, number name recognition, number lines, sorting and counting. The final learning activity is the ebook which recaps what has been learned and acts like a plenary for each *Mathseeds* lesson to consolidate new concepts and skills. The final part of each lesson is a pet hatching animation. Each lesson ends with the hatching of a unique pet that is added to the *Mathseeds* map. This is a highly motivational element for children who look forward to seeing which animal will be next. These hatching pets act as both a reward for lesson completion and they also encourage children to proceed to the next lesson in the program.

In addition to the core lessons, the *Driving Test* area of the program offers a wide range of tests that assess skills and knowledge in number, operations, patterns, measurement, geometry and data. While the *Number Facts* area of the program focuses on building fluency with basic facts, this section brings mental arithmetic to life, where students can engage in a huge range of fun activities that develop number fact fluency.

Active Engagement

"...behavioural engagement encompasses the idea of active participation and involvement in academic and social activities, and is considered crucial for the achievement of positive academic outcomes." (Attard, 2012, p.10)

Research indicates that mathematical engagement occurs when students *enjoy* the subject of mathematics, *value* their mathematics learning and *see the relevance* of it in their lives. The ability to *make connections* between the mathematics that is taught in class and the mathematics that is applied in the outside world is crucial (Attard, 2012; Roschelle, Pea, Hoadley, Gordin & Means, 2000). Similarly, Willis (2014) has stated that "Relevance increases engagement and reduces boredom when students recognise instruction as related to their interests..." (p.30). It is engagement, rather than memorisation tasks that activates more pleasure structures in the brain (Poldrack, Clark, Pare-Blagoev, Shohamy, Creso Moyano, Myers & Gluck, 2001).

In recognising the importance of this research, the lessons and *Playroom* activities encourage students to make connections between their experience of the real world and mathematical thinking. Anthony & Walshaw (2009) in their research commented how

"Making connections across mathematical topics is important for developing conceptual understanding... When students find they can use mathematics as a tool for solving significant problems in their everyday lives, they begin to view the subject as relevant and interesting." (p.156)

New skills and concepts are taught in a context that is relevant, familiar and of interest to most young children. From choosing the correct bus as it drives by, to feeding birds the correct number of worms in a bird café, to getting an astronaut back to his rocket ship, the *Mathseeds* activities bring mathematical concepts to life. And with more than 350 different activities, students are always seeing content that is new and interesting. For students working through the program, the *Mathseeds* lessons and activities are all set in a non-threatening environment that supports risk taking and rewards perseverance.

"In the mathematics classroom engaged students are:

- *actively participating — group discussions, practical, relevant activities and homework tasks*
- *genuinely valuing — 'This learning will be useful to me in my life outside the classroom'*
- *reflectively involved in deep understanding of mathematical concepts and applications, and expertise."*

Dr Catherine Attard, Lecturer in Primary Mathematics, 2012

Instructional Formats

"Engage students by utilising a variety of rich and challenging tasks that allow students time and opportunities to make decisions, and which use a variety of forms of representation." (Sullivan, 2011, p.26)

At the core of *Mathseeds* are the instructional movies and interactive activities that make up the beginning of each lesson. Both the movies and activities have been purposely designed to encourage active learning rather than what Roschelle & his colleagues referred to as the "passive role of receiving information" (2000, p.79). Evidence supports the belief that students learn best when they are provided with short sessions, quick instructional pace and time to process new information (Fuchs and Fuchs, 2001; Jensen, 2005). As shown in *Figure 4*, Jensen (2005) recommends 5–8 minutes direct instruction for early primary school students. The Mathseeds instructional video sequence is interspersed with short, interactive activities which serve as practise and consolidation, as well as a method for keeping students focussed.

Guidelines for Direct Instruction of New Content

Year level	Appropriate Amont of Direct Instruction
K–2	5–8 minutes
Years 3–5	8–12 minutes
Years 6–8	12–15 minutes
Years 9–12	12–15 minutes
Adult learners	15–18 minutes

Figure 4: Jensen (2005) identified appropriate durations for direct instruction for children.

Figure 5: *Playroom,* students are asked to continue simple patterns.

The *Mathseeds Playroom* contains several activities that have been designed for young children. They are a combination of open-ended tasks, such as stamping shapes to create a picture, or specific tasks such as popping balloons on a 0–9 number line. *Figures 5–8* show these learning activities in action. The activities take into consideration the short concentration spans of young children, but several activities loop for as long as the child wants to engage and play.

Figure 6: *Playroom, students are playing with cardinality.*

Figure 7: *Playroom,* students are exploring measurement.

Figure 8: *Playroom,* students are identifying numbers and coloring.

"Over the past decade a suite of studies focused on the early bases of mathematical abstraction and generalisation has indicated that an awareness of mathematical pattern and structure is both critical and salient to mathematical development among young children."

Joanne Mulligan, Associate Professor, Macquarie University

Interactive activities are by their nature, more compelling than paper and pencil activities. A study by Moyer, Niezgoda & Stanley (2005) revealed the high level of creativity and complexity demonstrated by kindergarten students using virtual manipulatives and software, as opposed to concrete materials. *Mathseeds* lessons use short and varied activities to maintain student interest and regular rewards to boost motivation. The activities are playful so that students see them as an extension of how they play – and this means students are more likely to be fully involved and immersed in the activity, which also helps to build stronger connections and boost memory retention of new skills. Many of the *Mathseeds* instructional movies end with a song. This acts as an additional way for students to remember mathematical concepts in a fun and engaging way (Hayes, 2009; Jensen 2005).

One important feature of the *Mathseeds* instructional format is that on completion of every activity, the student receives immediate encouragement, feedback and error correction in a non-threatening way. Feedback in the early stages of learning is essential for keeping students on track and focussed (Garnett 2005; Griffith & Burns 2012; Jensen, 2005). Hattie and Timperley (2007) reveal that "... the most effective forms of feedback provide cues or reinforcement to learners... in the form of video-, audio-, or computer-assisted instructional feedback..." (p.84). This view is shared by Roschelle et al. (2000) who confirm that computer technology encourages rapid interaction and feedback. Students who receive this type of prompt feedback are more likely to be motivated to continue (Fuchs & Fuchs, 2001).

The interactive activities that follow each lesson give students vital opportunities to review, revise and repeat new skills (Jensen, 2005). They allow students to build on their knowledge and see the links between mathematical ideas, as evidenced as important by Anthony & Walshaw (2009). In keeping with the concept of a spiral curriculum (Bruner 1960), the *Mathseeds* program is structured so that ideas introduced in early lessons are later re-visited at a more advanced level. Mathematical vocabulary is introduced early in order to prepare students for future, more complex learning (Anthony & Walshaw, 2009; Jensen, 2005).

"Pluralization achieves two important goals: when a topic is taught in multiple ways, one reaches more students. Additionally, the multiple modes of delivery convey what it means to understand something well. When one has a thorough understanding of a topic, one can typically think of it in several ways, thereby making use of one's multiple intelligences."

Howard Gardner, Developmental Psychologist, Harvard Professor

Learning Styles and Multiple Intelligences

"How students process information – how well they learn and how well they retain knowledge – is directly related to the learning style of the individual"
(Manner, 2001, p.390)

Much has been written regarding individual learning styles and multiple intelligences; their importance and implications for learning (Adams 2000; Bloom 1956, Clausen-May, 2005; Green 1999; Tiberius & Tipping, 1990). The work of Gardner (2011) identifies the variety of intelligences that students apply in learning situations, highlighting the fact that not all children learn in the same way and require programs that reflect their different approaches to learning (Adams, 2000). The scope of Gardner's work on discrete multiple intelligences is demonstrated by *Figure 9*. Educators can engage with the widest possible audience where they design activities that utilise this broad range of intelligences for their students.

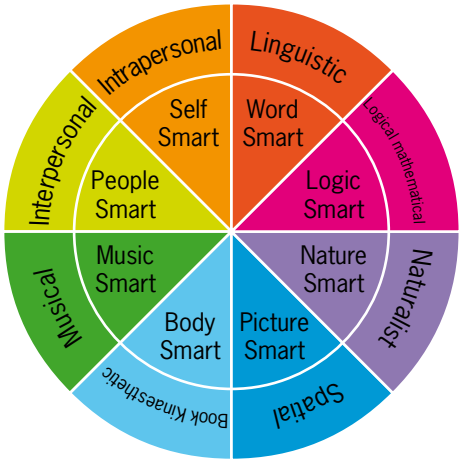

Figure 9: Howard Gardner's Multiple Intelligences

Mathseeds is designed to appeal to different learning styles and multiple intelligences. The program's content and variety allow all students the opportunity to engage in mathematical learning. The following examples illustrate how *Mathseeds* caters for multiple intelligences.

- **Logical/Mathematical**

Mathseeds appeals to those who think logically. There are opportunities within the program for students to calculate answers, solve problems with numbers, draw conclusions, explore the relationships between numbers, shapes and statistical data, work with different representations of numbers, and gather and interpret information.

- **Verbal/Linguistic**

The program offers opportunities for seeing, saying, counting, reading and writing numbers. The *Mathseeds Playroom* also offers opportunities for young children to hear and sing along with familiar nursery rhymes that reinforce counting and simple mathematical concepts such as days of the week.

"Good manipulatives are those that are meaningful to the learner, provide control and flexibility to the learner, have characteristics that mirror, or are consistent with cognitive and mathematical structures, and assist the learner in making connections between various pieces and types of knowledge."

Douglas H. Clements, Distinguished Professor, University at Buffalo

Throughout the program, children are encouraged to listen and follow instructions. There are opportunities to read and comprehend word problems and explore ways of converting problems to algebraic expressions. *Mathseeds* characters expose students to new mathematical expressions and assist them to explore mathematical vocabulary. Research indicates that these aspects should be modelled in order to enhance students' understanding (Runesson, 2005). At the end of each lesson, students can read ebooks that consolidate new concepts. The texts are professionally narrated which provide a model for the child's own reading fluency. *Figure 10* shows the layout and content for the ebook *Near Doubles* for Lesson 91.

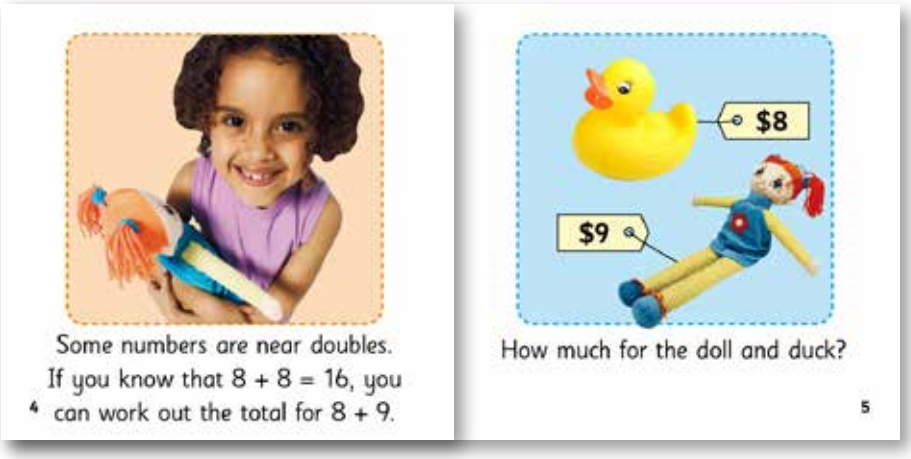

Figure 10: *Lesson 91,* ebook*, Near doubles.*

- **Visual/Spatial**

The *Mathseeds* program features high quality, colourful animations that have been designed to appeal to the visual learner. The onscreen graphics are bold, clear and engaging. Lesson progression is mapped in a fun and unique way. Students are taken to a range of virtual habitats. Stepping stones mark their progress through each habitat and on completion of each lesson, students move forward to the next stepping stone. This creates a very powerful and visual way of helping students see the progress they are making and ensures that they stay motivated towards their goals. Making progress visible to students is articulated in research as being a key goal (Adams & Hamm, 2014; Marzano, 2007; McLennan and Peel, 2008).

In addition, each *Mathseeds* lesson is accompanied by an ebook, created from quality, full colour illustrations. The program also has accompanying posters and worksheets to consolidate learning and increase information processing.

- **Bodily/Kinaesthetic**

Mathseeds offers kinaesthetic learners the ability to engage their senses and create an experience that goes beyond simply learning by rote which Clausen-May (2005) identifies as crucial. Early number concepts are taught in a very visual and kinaesthetic way and encourage students to see numbers as wholes. The first *Mathseeds* song 'There is only one of me' encourages the student to see and *feel* that they have *only* one nose, *one* face, *one* mouth etc.

Bobis (2008) in her research identifies how virtual manipulatives can assist students with number sense and spatial thinking. In *Mathseeds* students are encouraged to subitise early on and the presence of dominoes, dots, and various other engaging items to count are available for *all* students to use – not just the kinaesthetic learners. Research indicates that when given the appropriate materials, students can mentally combine and partition numbers. This is an important skill prior to the introduction of addition and subtraction (Bobis, 2008).

Early addition lessons physically show the main character joining two distinct sub-groups together to form one group, or total. Only when this concept of addition is in place does the program present addition in the form of a simple number sentence and eventually as a formal algorithm. *Figures 11–13* demonstrate the sequential building of this conceptual knowledge.

Figure 11: *Lesson 24,* characters are exploring two distinct groups and joining them together to find the total.

Figure 12: *Lesson 51,* characters are adding and locating the final counted numeral as the total on a number line.

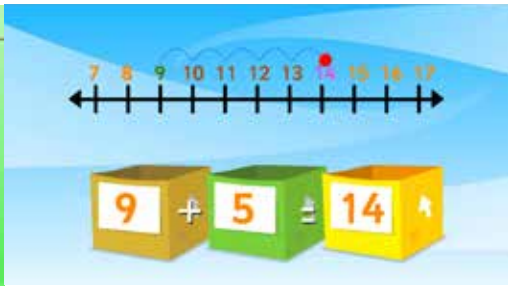

Figure 13: *Lesson 65,* characters are creating formal number sentences from pictorial representations.

Similarly, subtraction is taught through more than one approach. Students physically take items away from the main group when learning how to subtract. They also learn to cover items up, and eventually progress to counting back along a number line, using subtraction number sentences and finally formal algorithms. This multi-level and kinaesthetic approach allows students to understand *why* a method works, rather than *how* to just solve a problem (Clausen-May, 2005).

- **Musical**

Mathseeds is full of playful songs that act as mnemonics to aid memory and consolidate new concepts. The songs are popular amongst children and perfect for those who have sensitivity to music. The *Mathseeds Playroom* has a number of traditional nursery rhymes and familiar songs that reinforce simple counting skills and other mathematical ideas.

Aspects of rhythm are also used to teach mathematical concepts such as patterning. According to Mulligan (2010), “an awareness of mathematical pattern and structure is both critical and salient to mathematical development” (p.47). In *Mathseeds* students are encouraged to participate in simple dances, led by the onscreen characters, to demonstrate the idea of repeating patterns. *Figure 14* is an example of one such song from Lesson 66 about fractions.

Figure 14: *Lesson 66,* characters singing a fraction song about quarters.

- **Interpersonal/Intrapersonal**

The *Mathseeds* program can be used in a variety of ways to promote interpersonal and intrapersonal skills. It can be used with a whole class or for a focussed group lesson. It encourages talk and discussion, sharing and group participation. The program can also be used on an individual basis for students who prefer to work alone at their own pace. It allows for thoughtful reflection on individual progress.

Mathseeds lessons encourage students to think about how they use mathematics outside the lesson. This provides opportunities for students to draw on their own experiences and construct their understandings of the real world (Perry, 2000; Tiberius & Tipping; 1990). In *Mathseeds* the onscreen characters model how to solve problems through discussion and rationalising. They effectively teach students how to monitor the problem solving process and demonstrate for students how a collaborative atmosphere enhances learning.

"In order to become capable and strategic learners in mathematics, pupils need to have confidence in their own ability and self-identity as learners of mathematics. Strategies that promote inclusiveness, deep thinking, and ownership, can have a powerful effect on building pupils' mathematics skills."

Chris Kyriacou, Professor in Educational Psychology, University of York

"A student's motivation for learning is generally regarded as one of the most critical determinants of the success and quality of any learning outcome."

Sheri Coates Broussard & M. E. Betsy Garrison, Louisiana State University

Motivational Elements

When addressing the issue of how to interest and engage students, Sullivan and McDonough (2007) refer to the student's "willingness to persist" (p.698). This "willingness" is the motivation required for students to complete learning activities. Motivation plays a key role in learning (Gagne & Deci, 2005; Jensen 2005; Rodionov & Dedovets, 2011; Sullivan & McDonough, 2007; Taylor & Adelman, 1999). Intrinsic motivation rewards students purely for participating in the activity itself, whereas extrinsic motivation is derived from gaining awards such as certificates or verbal rewards (Gagne & Deci, 2005; Ryan & Deci, 2000). These important, positive rewards impact on student motivation (Griffith & Burns, 2012; Jensen 2005). *Mathseeds* seeks to provide both intrinsic and extrinsic motivational rewards in order to produce total satisfaction.

Rewards reinforce existing learning and encourage new learning to occur. The brain responds favourably to rewards, the potential for rewards (prediction) and to unexpected rewards (surprise). It releases a sudden burst of dopamine that makes the student feel good and motivated to continue with the task (Bear, Connors & Paradiso, 2007; Jensen, 2005)

The *Mathseeds* program rewards students with a cute pet that hatches from an acorn at the end of each lesson sequence. The first time this happens is an unexpected surprise for the student. After subsequent lessons the student knows it will happen (prediction) but they still have the element of surprise as they do not know what each pet will be until it hatches.

According to Edward de Bono, "Humour is by far the most significant activity of the human brain" (de Bono cited by Griffith and Burns, 2012, p.61). The *Mathseeds* program actively motivates students through its elements of humour and playfulness. Each hatching pet has its own unique character that students can enjoy. In addition, the five key characters are role models for students; exploring new mathematical challenges and having fun whilst they learn.

Learning is an ongoing, dynamic process and the learning environment must continuously change to reflect this (Taylor & Adelman, 1999). The *Mathseeds* program moves through different locations, with regard to the lessons and reward maps. The key characters remain the same but they present the lessons intermittently to maintain student interest. The huge range of interactive activities are uniquely written and animated in different styles to prevent students from becoming bored and demotivated.

According to Taylor & Adelman (1999), "One of the most powerful factors for keeping a person on task is the expectation of feeling some sense of satisfaction when the task is completed' (p.266). *Mathseeds* rewards students with golden acorns at the completion of each lesson and activity. These get banked and can later be spent on clothes for the student's avatar (online character) or furniture for their personal tree house.

After the completion of five lessons, students participate in an online quiz. If they pass, their efforts are rewarded with a printable certificate that has their name on and will be either a gold, silver or bronze award. Providing a representation of a very personal accomplishment can be a valuable motivator to improve student achievement (Marzano, Pickering & Pollock, 2001). The range of rewards that *Mathseeds* offers students actively encourages them to engage with the program, to explore it, to learn from it, and to value their progress.

"Choosing engaging experiences as contexts for a variety of tasks assists in making mathematics inclusive, and these tasks can be effectively differentiated both for students experiencing difficulty and those who complete tasks easily."

Australian Curriculum Assessment and Reporting Authority, 2015

Assessment & Reporting

Assessment is necessary to monitor progress, to identify strengths and weaknesses, and to inform further instruction (ACARA, 2015). *Mathseeds* weaves student-facing assessment seamlessly throughout the program. Detailed reports keep teachers informed as to where individual students are in reaching their goals. By basing all lessons and assessment on the Australian Curriculum achievement standards, teachers and school leadership staff can make informed judgments about student understanding against national standards.

Mathseeds includes both summative and formative assessment opportunities. These assessments present students with multiple avenues to show their knowledge and have distinct structures to cater for a wide range of students.

Mathseeds provides multiple opportunities for informal assessment through the range of interactive activity types. These increase in difficulty by gradually removing supports like reminders and visual manipulatives as students demonstrate competency. The gradual removal of scaffolds reduces the potential for anxiety and boosts student success. For students, interactive activities offer immediate feedback and the ability to correct errors. These are critical to ensure students continually self-monitor their understanding.

Mathseeds End-of-Map Quizzes and Driving Tests provide formal assessment opportunities. At the completion of every five lessons students complete a 15 question assessment quiz. This assesses student understanding of the content covered in the latest map with results appearing in teacher reports. The Driving tests are 10 question tests that assess student knowledge in essential mathematics skills. These assessments have responsive feedback that requires students to redo questions answered incorrectly. This allows students to critically evaluate incorrect responses to reinforce correct mathematical thinking.

Another assessment component can be found in the teacher toolkit, where teachers can choose from a range of printable Australian Curriculum assessment tasks that can be used with individual students, groups or the whole class. In the Australian Curriculum, the achievement standards allow teachers "to make a balanced judgement about the quality of learning demonstrated" (ACARA, 2015). To do this, teachers need data and *Mathseeds* provides rich assessment data to aid both in reporting and to inform targeted teaching.

"One of the chief benefits of mobile devices is that they enable learning anywhere, anytime. This allows a shift away from the industrial era model where the classroom is the central place of learning driven by the teacher and limited to instruction within the school day. In deploying mobile devices, the teacher is no longer at the centre of the learning process and the instructional time can transcend the school day."

Dr Kristy Goodwin, Institute of Early Childhood, Macquarie University, 2012

Technology

As technology permeates all aspects of interactions, it has become "an ubiquitous tool for teaching and learning" (Li & Ma, 2010, p.215).

Cheung & Slavin (2013) identify that as technology permeates 21st century living, the question for teachers shouldn't be whether to use educational technology but rather what applications ensure it is incorporated in the best way for students (p. 102). Technology that enables the manipulation of virtual objects is powerful (Hoyles & Noss, 2009), as are regenerative question designs that afford endless practise opportunities. By its design, the *Mathseeds* program takes advantage of the inherent benefits of computer technology. The program allows children to manipulate objects in a variety of ways, to experiment without fear of failure and test out their new skills through a range of practice opportunities. Accessible on desktop and mobile devices it bridges the home and school divide working to connect family and school communities in the learning process.

Research indicates the most powerful potential for tools are where meaningful interactions operate alongside sound teaching and learning strategies (Coley, Cradler & Engel, 2000) and guided support (Moyer et al., 2005). *Mathseeds* is an innovative interactive teaching and learning resource designed by educators to connect students to the key concepts of number sense. In teaching and learning sequences, students play with virtual manipulatives in short, focused sequences. This teaching is always linked to content in the lesson that follows and is a scaffold to provide guided support for activities within the lesson sequence.

Conclusion

Mathseeds is an interactive Web-based program that incorporates a huge range of highly structured, effective, research-based activities. It combines rigorous learning with high interest level activities, taking into consideration the needs, learning styles and future direction of learners in the 21st century. *Mathseeds* has been built on best practise in pedagogical research alongside core curriculum initiatives, creating a program that is both educationally sound and highly motivating. *Mathseeds* lessons provide an engaging environment for young children who learn best through play. The instructional elements and interactive activities are set in contexts that are meaningful and relevant. The program offers a range of age-appropriate rewards that actively encourage students to engage with the program, to explore it, to learn from it, and to value their progress.

Mathseeds is designed to seamlessly connect learning between school and home, making learning possible anywhere and easily accessible on different devices. Its comprehensive assessment and reporting procedures allow students, parents and teachers to receive instant feedback on progress and achievements made. Written by experts with over 25 years of experience in creating high quality educational resources, *Mathseeds* has been carefully designed to maximise student learning and to equip students with the strongest foundation possible to achieve lifelong mathematical success.

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