An Roinn Oideachais
agus Óige
Department of Education
and Youth

Science, Technology, Engineering and Mathematics (STEM) Education Specification

For Primary and Special Schools

Prepared by the National Council for Curriculum and Assessment (NCCA)

2025


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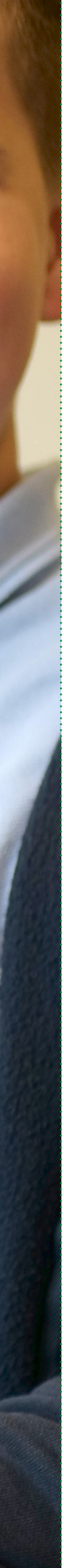

Contents

Introduction to *STEM Education*

Building strongly on children's experiences through *Aistear: the Early Childhood Curriculum Framework*, *STEM Education* nurtures children's natural curiosities, encouraging them to explore, question and engage with the world around them. In bringing *Science, Technology and Engineering Education* together with Mathematics, children in primary and special schools can develop the ability to think critically, analyse and solve problems and apply mathematical reasoning, through play and discovery, in ways that are practical and meaningful to their lives and others, sparking a lifelong love and enthusiasm for *STEM Education*.

STEM Education is one of five curriculum areas in the redeveloped primary curriculum, marking a significant step in strengthening STEM learning in primary and special schools across Ireland. The *STEM Education* specification is presented in three parts:

- The *Science, Technology and Engineering Education* specification
- An Approach to Integrated STEM Learning
- The *Primary Mathematics Curriculum*

The *Primary Mathematics Curriculum* provides a strong foundation in mathematical thinking and problem-solving through the study of the relationships, connections and patterns that surround us. Mathematics provides an important foundation for children's STEM learning by helping children to understand, apply and connect their learning across science, technology and engineering in meaningful ways.

Science, Technology and Engineering (*STE*) *Education* ensures that children will have opportunities to develop their knowledge and skills in working with ideas and processes relevant to science, technology and engineering. It places an emphasis on developing children's awareness and appreciation of the nature of STEM, while engaging in scientific inquiry, computational thinking and the design thinking process. These *STE Education* processes naturally provide opportunities to apply and integrate mathematical concepts and skills.

The *STEM Education* specification builds on the *Primary Curriculum Framework's* focus on integrated learning. It includes a section on 'An Integrated Approach to STEM Learning' as a bridge to support teachers to connect different parts of the curriculum. The approach promotes the use of meaningful contexts for children's learning where children can explore problems, challenges and questions of interest and relevance to their lives. Drawing on their learning across STEM subjects, children can apply their knowledge and skills in practical ways, supporting a cohesive and engaging *STEM Education* experience.

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Science, Technology and Engineering Education Specification

For Primary and Special Schools

Preface

The *Science, Technology and Engineering* (*STE*) *Education* specification is for all children attending primary and special schools. It is inclusive and holistic in nature, recognising primary and special education as a time of 'being' and 'becoming' – connecting with children's prior learning, celebrating children's current experiences and looking to their futures.

Building on the *Primary Curriculum Framework*, the redeveloped curriculum's specifications work together to provide a strong foundation for every child to thrive and flourish, supporting them in realising their full potential as individuals and as members of communities and society.

The *STE Education* specification places an important emphasis on child and teacher agency, ensuring children have a meaningful say in their learning and supporting teachers in making informed professional decisions within the parameters of the curriculum.

The *STE Education* specification is part of the wider redevelopment of the Primary School Curriculum. A particular focus has been placed on ensuring coherence across the specifications. As you get to know the specifications, you will notice a consistent structure and use of terminology, chapters and subsections of similar lengths and the avoidance of unnecessary duplication and repetition of Learning Outcomes. You might also recognise many of the positive aspects of current practice that take place in our primary and special schools, as well as enhancements in the learning children will experience through the pedagogical and assessment approaches supported across the curriculum.

1. Introduction

Every child in Ireland has the right to an education based on their strengths, interests and needs. The *Primary Curriculum Framework* aims to provide a strong foundation for every child to thrive and flourish, supporting them in realising their full potential as individuals and as members of communities and society. It recognises primary education as a time of 'being' and 'becoming' – highlighting the importance of enjoyable, interesting, relevant and appropriately challenging experiences for all children that empower them as learners both now and into the future. Importantly, the Primary School Curriculum supports high-quality learning, teaching and assessment for all children attending primary and special schools.

Science, technology and engineering are integral components of our everyday lives, continually advancing and shaping our world. *Science, Technology and Engineering* (*STE*) *Education* provides children with opportunities to explore, investigate and interpret our world and beyond. Children learn that in light of new discoveries and technological advancements, problems can be solved, enabling rapid adaptability and changes to how we live in the world. *STE Education* supports children in developing the knowledge, concepts, skills, dispositions, attitudes and values required to make informed decisions and explore local, national and global challenges. The wider benefits of learning in *STE Education* include developing STEM literacy, building resilience, fostering creativity and nurturing the ability to engage in child-led inquiry and design.

From birth, children begin their educational journey through interactions and experiences with the world around them. In primary and special schools, children have playful and engaging learning experiences that build upon the knowledge, skills, concepts, dispositions, attitudes and values they have acquired at home and in preschool settings through *Aistear: the Early Childhood Curriculum Framework*. As children move through primary or special school, their learning connects with, and is further progressed through, the learning experiences provided in post-primary school. Given the diversity in the contexts in which children learn and the uniqueness of each child's learning journey, the curriculum promotes agency and choice and acknowledges that teachers play a critical role in facilitating equitable, meaningful and holistic learning experiences for all children.

Principles of learning, teaching and assessment

Eight overarching principles underpin and guide schools in pursuing the vision of the *Primary Curriculum Framework*. These principles convey what is valued in primary and special education and what lies at the heart of high-quality learning, teaching and assessment in the primary curriculum. They are broad in nature to reflect varied school contexts and children's different circumstances, experiences and abilities. As such, they support boards of management, school leaders, teachers and others in their duties to ensure high-quality education is provided for all children in our schools.

Table 1 presents a non-exhaustive set of examples of the principles in action within the *Science, Technology and Engineering Education* specification.

Table 1: Principles of learning, teaching and assessment

Principle of learning, teaching and assessment	Examples within the *Science, Technology and Engineering Education* specification
Assessment and progression	• Assessing and celebrating children's engagement in the process of *STE Education* learning, their solutions and conclusions • Encouraging children to actively engage in reflection and self-assessment throughout scientific inquiry, design and problem-solving tasks • Using a range of assessment methods that are suited to the hands-on and minds-on nature of *STE Education*, such as observation and portfolios
Engagement and participation	• Facilitating hands-on and minds-on learning • Encouraging participation by making links to children's interests, lived experiences and local environments • Promoting opportunities to engage in collaborative *STE Education* activities and tasks through pair work, groupwork, whole class contexts and with the wider school community
Inclusive education and diversity	• Fostering child-led learning that taps into children's natural curiosities for the benefit of all learners • Facilitating inclusive and appropriately challenging STEM tasks • Challenging stereotypes within the world of STEM and nurturing empathy, mutual respect, collaboration and children's unique contributions to discussions and tasks
Learning environments	• Using a range of learning environments, including outdoor learning spaces, that encourage exploration, investigation and creativity • Attending exhibitions and tours, where possible, to encounter different perspectives and deepen learning experiences • Celebrating children's learning by presenting and sharing discoveries, designs and solutions
Partnerships	• Inviting members of families and the local community to speak about STEM in their lives and to be an audience for displays and presentations of learning • Creating links or clusters with neighbouring preschools, primary, special, and post-primary schools to collaborate on STEM projects or tasks • Collaborating with scientists, engineers and people working with technology, locally or online

Principle of learning, teaching and assessment	Examples within the *Science, Technology and Engineering Education* specification
Pedagogy	• Using appropriately playful, engaging and evidence-based pedagogical approaches and strategies as described in Section 6b • Providing opportunities for inquiry-focused, active and practical learning experiences where children can apply existing learning and acquire new knowledge and skills as outlined in An Approach to Integrated STEM Learning • Encouraging children to investigate situations and solve problems that are closely related to their everyday lives, circumstances and interests
Relationships	• Presenting projects and sharing learning reflections with others in the school community to increase engagement and to support learning • Fostering collaboration across the school community through STEM investigations and problem-solving tasks • Designing and creating solutions for the benefit of the school community and the wider world; showing empathy and care to build positive relationships with others
Transitions and continuity	• Engaging in engineering activities and scientific inquiry to build on how children make sense of the world around them and to connect with the Themes of *Aistear* • Fostering children's sense of self-identity as scientists, engineers and users and creators of technology • Drawing awareness to Biology, Physics, Chemistry, Engineering and the range of Technology subjects that children can encounter at post-primary school

Overview of the *Science, Technology and Engineering Education* specification

The opening chapters of the *Science, Technology and Engineering Education* specification present the Rationale, Aims, Strands and Elements and Learning Outcomes. Chapter 6 provides guidance on the curriculum in practice, while the final chapters present an overview of the online toolkits, the glossary and references.

The *Science, Technology and Engineering Education* specification is supported by the online Primary Curriculum Toolkit and the *STE Education* Toolkit. These online toolkits offer a variety of supports in enacting the curriculum, including supports for curriculum planning, inclusion, assessment and pedagogy. You can access the online version of the specification and the toolkits by visiting www.curriculumonline.ie.

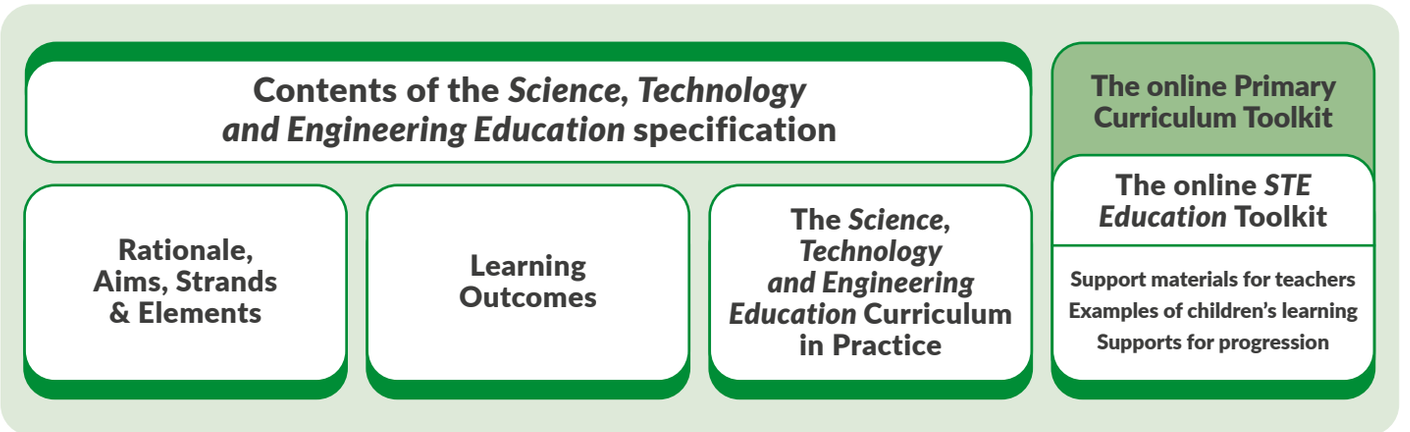


Figure 1: Contents of the *Science, Technology and Engineering Education* specification

2. Rationale

Science, Technology and Engineering Education enables an understanding and appreciation of our local environments and the wider world. It inspires children to explore and learn about nature, materials, the living world and energy and forces. It supports children's learning regarding rapidly changing technological advancements, as well as human endeavours to design and create, all of which impact their daily lives.

Science, technology and engineering are intrinsically linked. Learning in *STE Education* fosters diverse perspectives and skill sets, empowering children to ignite their creativity, make informed decisions and solve problems.

Children are instinctively curious and natural investigators, designers and creators

STE Education evokes children's innate curiosity and develops their ability to investigate, design, construct and communicate effectively. Children can experience and investigate the world around them, through hands-on and minds-on engagement in *STE Education*. Through these learning opportunities, children can develop individual interests, learn important life skills and build confidence and resilience.

Science, Technology and Engineering Education provides us with a greater understanding of our world

Science, Technology and Engineering enhances our ability to interpret the world. It plays an important role in responding to significant global challenges. Learning about *STE Education* empowers children to become responsible citizens who respect nature and value their local and wider environments. *STE Education* creates possibilities to address human needs and realise solutions to everyday and emerging problems. Applying scientific knowledge and skills to engineering and technology tasks helps children to see the true nature of our interconnected world and enriches the value of their learning.

Science, Technology and Engineering Education nurtures real-world problem-solving skills

Problem-solving is central to *STE Education*. Through working with real-world and imagined problems, children can identify challenges, break them down into manageable components and develop possible solutions. Problem-solving requires creative and critical thinking, as well as perseverance. Problem-solving fosters a sense of empowerment and demonstrates to children that they have the capacity to make a positive impact on their own lives and the lives of others.

Science, Technology and Engineering Education connects with children's experiences and interests

STE Education is relevant to all children's lives, connecting their learning experiences with their interests. The exploratory nature of *STE Education* makes it a natural space to engage in play and playful learning using everyday items found in schools, as well as contemporary and emerging technologies. It also offers a route into developing children's awareness of environmental issues and the need for design solutions that protect resources and enable sustainable living. It can provide limitless opportunities to cultivate and nurture children's imagination, creativity and innovation.

Science, Technology and Engineering Education fosters agency in children

STE Education provides children with opportunities to engage in decision-making about how to conduct a scientific inquiry, how to design for a purpose and how to create with technology. While engaging in *STE Education*, children are encouraged to guide their own learning, make informed choices and take calculated risks. They can demonstrate resilience and adaptability where obstacles are encountered, or plans need to be modified. Nurturing agency through open-ended, child-led learning experiences can build competent and confident decision-makers and problem-solvers.

3. Aims

Science, Technology and Engineering Education supports children's capacity to understand and engage fully with the world around them.

The *Science, Technology and Engineering Education* specification aims for children to:

develop their curious disposition.

Explore the world with curiosity and playfulness and develop an appreciation for the endless possibilities of Science, Technology and Engineering.

develop STEM skills.

Develop, use and adapt a variety of Science, Technology and Engineering skills in effective ways.

build conceptual and procedural understanding.

Understand and apply key Science, Technology and Engineering concepts and procedures.

create and innovate.

Use imagination and creativity to generate ideas, make discoveries and explore possible solutions to real-world and imagined problems in Science, Technology and Engineering.

develop critical thinking.

Be open-minded whilst questioning, discussing and making judgements using evidence.

communicate ideas and use disciplinary language.

Develop, use and apply Science, Technology and Engineering language in order to communicate, evaluate and reflect on learning experiences.

4. Strands and Elements

Strands

Strands outline the main categories of children's learning in *Science, Technology and Engineering (STE) Education*. The six strands are:

- Nature of STEM
- Living things
- Materials
- Energy and forces
- Technology
- Engineering

The division of the *STE Education* specification into strands offers a clear and structured way to present the Learning Outcomes. However, these strands are interconnected rather than discrete. Therefore, in any given lesson, a teacher may naturally address multiple Learning Outcomes at the same time.

Elements

Elements describe the processes children engage in as they learn in *STE Education*. These elements support our understanding of how children learn. The four elements in *STE Education* are:

- Exploring and understanding
- Creative and critical thinking
- Applying and problem-solving
- Evaluating and communicating

Table 2: Elements in the *Science, Technology and Engineering Education* specification

Element	Description
Exploring and understanding	Children are natural explorers and enjoy opportunities to ask and explore questions of interest, engage in active learning and construct their understanding through collaboration with others. Through focused exploration, children's natural curiosities and interests can be sparked, leading to discoveries and a deeper understanding of the intrinsically linked nature of Science, Technology and Engineering.
Creative and critical thinking	*STE Education* provides a natural space for play and playful learning. Children make innovative discoveries and explore solutions in response to real and imagined challenges. They can think creatively and critically while experimenting and designing. Children can take calculated risks and lead their own learning experiences.
Applying and problem-solving	Problem-solving and investigating are integral to learning in *STE Education*. Children apply their knowledge, skills and dispositions to solve problems of interest in creative and meaningful ways. They work collaboratively to use a range of strategies where they can apply and test their ideas and designs. Children plan, observe and record their findings, refining their understanding through reflection and evaluation. Importantly, they can build perseverance and resilience as learners through problem-solving learning experiences.
Evaluating and communicating	Children use appropriate language and/or means of communication to convey ideas and perspectives, present their thinking, justify pathways and draw conclusions from evidence. Through inquiry and collaboration, children develop their ability to communicate and present their ideas to others. They can analyse and critically evaluate the effectiveness of a proposed or complete solution and share feedback on their ideas, strategies and contributions.

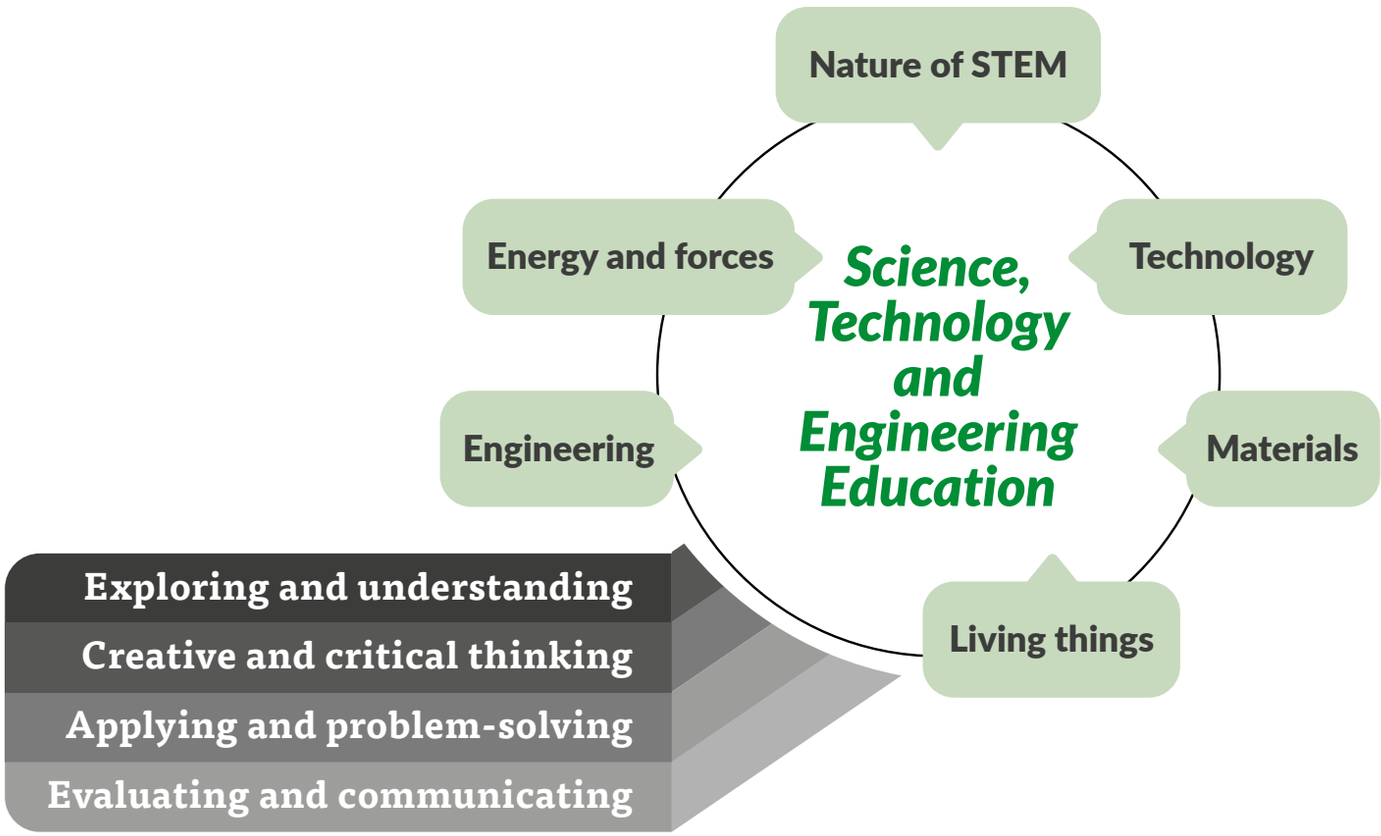


Figure 2: The strands and elements in the *Science, Technology and Engineering Education* specification

5. Learning Outcomes

Central to nurturing every child's potential is the clear articulation of Learning Outcomes. This chapter presents the Learning Outcomes for *Science, Technology and Engineering* (*STE*) *Education*. Learning Outcomes describe the expected learning and development for all children at the end of a two-year stage, when due account is taken of individual abilities and varying circumstances. They focus on children's understanding, which develops through the acquisition and gradual building of knowledge, skills, concepts, dispositions, attitudes and values in *STE Education*.

Reflecting the principles and pedagogical approaches in the *Primary Curriculum Framework*, the 'stem' '*Through appropriately playful and engaging learning experiences*' is used to introduce Learning Outcomes across all stages. This stem aims to foster a learning environment that facilitates rich learning experiences, as outlined in Chapter 6, '*Science, Technology and Engineering Education* Curriculum in Practice'.

Children learn and teachers teach in a variety of contexts. Learning Outcomes in *STE Education* are broad and balanced in nature to facilitate teacher agency and flexibility in schools. Given their broad nature, when working with Learning Outcomes, teachers can focus on specific aspects of learning, taking account of the context and prior learning of the children. When preparing for learning and teaching experiences, teachers can focus on particular aspects of a Learning Outcome or, at times, on aspects of multiple Learning Outcomes.

Key competencies

The primary curriculum has seven key competencies which overlap and combine to support the curriculum's vision. As outlined in the *Primary Curriculum Framework*, the competencies build on the capabilities children acquire through their early childhood education experiences with *Aistear* and are further strengthened in post-primary school through learning experiences shaped by the *Framework for Junior Cycle*. As children work towards the Learning Outcomes in the *Science, Technology and Engineering Education* specification and engage in rich learning experiences, they simultaneously build and develop these key competencies.

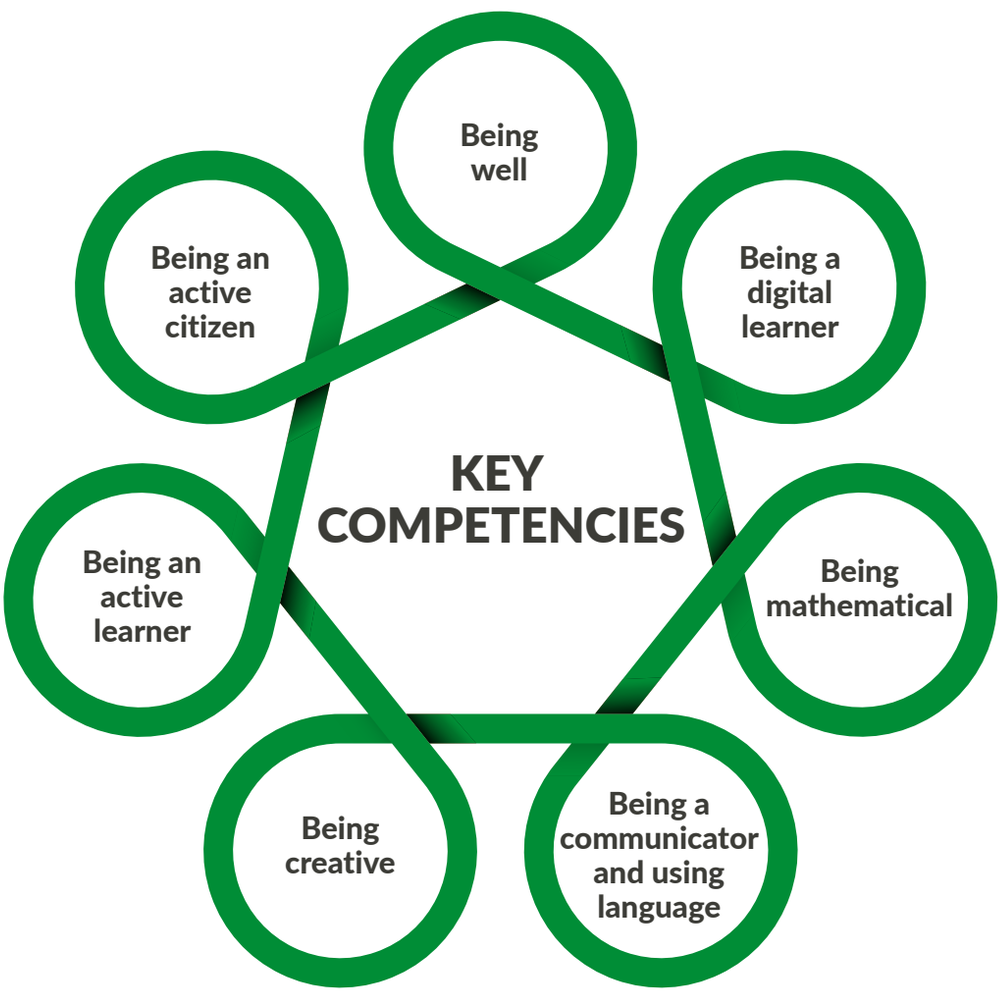


Figure 3: Key competencies

Table 3: Examples of attributes of each key competency developed through learning in the *Science, Technology and Engineering Education* specification

Key competency	Examples of attributes developed through learning in the *Science, Technology and Engineering Education* specification
Being an active citizen	• Searching for evidence and exploring solutions to problems in order to view different perspectives and to help others • Applying skills acquired through scientific inquiry, design thinking and computational thinking to real-world contexts
Being an active learner	• Engaging in active, playful, hands-on and minds-on learning in collaborative contexts • Participating in learning activities that involve informed risk-taking and promote relationship building
Being a communicator and using language	• Using *STE Education* vocabulary to co-construct and articulate ideas, discoveries, designs and solutions • Explaining and sharing the various ways that they have come to understand and apply ideas in Science, Technology and Engineering
Being creative	• Exploring solution pathways that can creatively address a question or challenge • Using creativity to make choices, choose pathways and lead their own learning
Being a digital learner	• Exploring and using a range of digital technologies to enhance how they learn about and work with Science, Technology and Engineering • Using digital technologies to design and create, fostering an awareness of the potential of the technological world
Being mathematical	• Exploring the ways that Mathematics underpins and enhances learning in *STE Education* • Consolidating and applying mathematical ideas to *STE Education* tasks and activities through a practical and playful approach
Being well	• Developing a tolerance for risk-taking and mistake making; while collaborating with others and building perseverance • Strengthening a sense of belonging, identity, motivation and confidence as learners and problem-solvers

To assist teachers in identifying the key competencies embedded within the Learning Outcomes, initials are placed beside each Learning Outcome, as explained in Table 4. In each instance, up to three key competencies are identified. It should be noted that in many instances, other key competencies, outside of the three identified, are also embedded in the Learning Outcomes.

Table 4: Key competency legend

Initials	Key competency
AC	Being an active citizen
AL	Being an active learner
CL	Being a communicator and using language
C	Being creative
DL	Being a digital learner
M	Being mathematical
W	Being well

Learning Outcomes for Strand: **Nature of STEM**			
Stage 1 Junior and senior infants	**Stage 2** First and second classes	**Stage 3** Third and fourth classes	**Stage 4** Fifth and sixth classes
Through appropriately playful and engaging learning experiences, children should be able to:			
explore and experience how people working in Science, Technology, Engineering and Mathematics (STEM) carry out investigations and help to solve problems, big and small, that impact our world. AL, DL, M	develop their 'STEM eyes' by exploring their immediate environment (home, school, play areas) and everyday objects through a STEM perspective. AL, DL, M	explore, discuss and investigate the history of STEM, the evolving nature of STEM and how STEM is infused within our society. AL, DL, M	identify and appreciate the key features of Nature of Science, Nature of Technology and Nature of Engineering. Explore and discuss topical STEM issues in Ireland and in the wider world. AC, AL, DL

Key competencies:

AC = Being an active citizen
AL = Being an active learner
CL = Being a communicator and using language
C = Being creative
DL = Being a digital learner
M = Being mathematical
W = Being well

Learning Outcomes for Strand: **Living things**

Stage 1 Junior and senior infants	**Stage 2** First and second classes	**Stage 3** Third and fourth classes	**Stage 4** Fifth and sixth classes
Through appropriately playful and engaging learning experiences, children should be able to:			
develop an awareness and understanding of the unique characteristics and functions of the external parts of the human body and the main phases of the human life cycle. AL, CL, W	understand and record the difference between living and non-living things. Identify and discuss the basic needs of humans to grow and thrive, including the importance of food for energy and growth. AL, CL, W	identify the main organs of the human body and develop an awareness of how they are situated within human systems. Investigate how an organ functions within a human system, how it keeps healthy and how it reacts to stimuli. AL, CL, W	identify and discuss the main systems of the human body and how they work together. Investigate how at least one human system operates. AL, CL, W
explore, investigate and appreciate the natural world outdoors. Observe, identify and sort plants and animals in their local habitats. Build an understanding of their physical characteristics and the basic conditions they need to survive and flourish. AC, AL, W	observe and identify a range of plants in both the local and wider environment. Design and conduct investigations into the conditions needed for plants to grow. Develop an awareness of how an animal grows and changes over its life cycle. AL	classify groups of plants and animals according to a range of criteria such as families/types, habitats, parts/movement and diet. AL, C, M	develop an understanding of the nutritional value of everyday foods and the importance of good nutrition on the human body. AL, M, W
use their human senses to explore, investigate and ask scientific questions about the natural world. AL, CL	use their human senses to explore, investigate and make scientific observations about the natural world. AL, CL	explore and investigate the interdependence of living things within ecosystems, how they adapt so they can survive and thrive and how basic food chains operate within them. AL, CL	demonstrate an awareness of how learning about Living things connects to the wider field of Biology and other 'Bio' fields. Explore and investigate how Science can serve to better understand and solve biodiversity related problems locally and/or nationally. AC, AL, CL

Key competencies:

AC = Being an active citizen
AL = Being an active learner
CL = Being a communicator and using language
C = Being creative
DL = Being a digital learner
M = Being mathematical
W = Being well

Learning Outcomes for Strand: **Materials**

Stage 1 Junior and senior infants	**Stage 2** First and second classes	**Stage 3** Third and fourth classes	**Stage 4** Fifth and sixth classes
Through appropriately playful and engaging learning experiences, children should be able to:			
explore a range of common materials found indoors and outdoors. Identify the main properties of these materials, what they are made of and the ways they can be used in different contexts. AL, CL	distinguish between natural and synthetic materials. Discuss the main properties of these materials and investigate how the properties compare and contrast. Ask testable questions to determine and evaluate what materials are most suitable for different circumstances. AL, CL, M	classify materials according to their properties, state (solids, liquids and gases) and their potential impact on the environment. AC, AL, CL	identify and discuss the properties of materials that need to be considered when constructing objects, structures, fashion and food. AL, CL, M research how the composition of everything around us, even air, has mass and is made up of tiny particles. CL, M
explore, observe and discuss the cause and effect of changes to everyday materials. AL, CL	plan, conduct and record scientific inquiries on how materials are affected by changes in temperature, composition and weathering. AL, C, M	plan, conduct, record and evaluate open-ended scientific inquiries into the effect of heating and cooling on common materials, including foods. Experiment and explore how some changes to materials can be permanent or reversible and determine which materials are better conductors or insulators of heat. AL, C, M	demonstrate an awareness of how learning about materials connects to the wider field of Chemistry. Explore and classify materials which are natural and manufactured. Conduct open-ended, fair test investigations into the consequences of combining, separating and changing materials. AL, CL, M

Key competencies: AC = Being an active citizen · AL = Being an active learner · CL = Being a communicator and using language · C = Being creative · DL = Being a digital learner · M = Being mathematical · W = Being well

Learning Outcomes for Strand: **Energy and forces**			
Stage 1 Junior and senior infants	**Stage 2** First and second classes	**Stage 3** Third and fourth classes	**Stage 4** Fifth and sixth classes
Through appropriately playful and engaging learning experiences, children should be able to:			
explore and identify common sources and forms of energy and investigate how energy makes things work. AL, CL	explore the role that energy plays in everyday life, how energy can be conserved in homes and schools and for the good of the planet. AC, AL, CL	identify and distinguish between renewable and non-renewable sources of energy and their sustainability. Explore common ways that energy can be stored and how forms of energy can be transformed. AC, AL, CL	research and investigate current environmental and societal issues related to energy, including the role that people are playing in reducing energy consumption and promoting the use of clean energy. AC, AL, M
explore and investigate the effect that different forces have on objects including pushing, pulling, floating and sinking. AL, CL	conduct scientific inquiries on how forces can affect the movement and motion of objects. AL, C, M	investigate and describe how forces can cause simple machines to operate. Using fair testing, investigate how forces can cause objects to move, stop and change speed, direction or shape. AL, M	demonstrate an awareness of how their learning about energy and forces connects to the wider field of Physics. Conduct open-ended investigations on friction, gravity and the force of moving water. AL, C, M
develop the skill of predicting through investigating the effect that magnets have on different materials. Discuss everyday uses of magnets. AL, CL	identify sources of sound in the environment. Investigate core ideas related to sound such as vibrations, volume and sound insulation. AL, CL	identify natural and artificial sources of light. Investigate core ideas related to light such as light as energy, the spectrum of colours and reflection, refraction and magnification. AL, CL, M	research how electricity works and conduct open-ended scientific inquiries using electric circuits. Identify and classify materials as electric conductors or insulators. AL, CL

Key competencies:

AC = Being an active citizen
AL = Being an active learner
CL = Being a communicator and using language
C = Being creative
DL = Being a digital learner
M = Being mathematical
W = Being well

Learning Outcomes for Strand: **Technology**

Stage 1 Junior and senior infants	**Stage 2** First and second classes	**Stage 3** Third and fourth classes	**Stage 4** Fifth and sixth classes
Through appropriately playful and engaging learning experiences, children should be able to:			
build on their awareness of a range of digital and non-digital technologies that they encounter in their everyday lives. Explore and discuss how these technologies help us and those around us to live and work in the world. AL, DL, W	explore and use a range of common digital and non-digital technologies. Consider how these technologies work and what purposes they serve in people's lives. AL, DL, W	explore how inputs, processes and outputs work together to make common digital and non-digital technologies function. Use and create with a range of technologies to assist and enhance their own learning and solve problems. Consider the advantages and disadvantages of these technologies in different contexts. AL, C, DL	identify and discuss the main components of at least one digital system and how it operates. Explore and identify the inputs, processes and outputs of this system. AL, CL, DL
through plugged and/or unplugged activities, explore how to decompose [break down] problems or processes into simple algorithms [sequences of steps]. Identify and recognise any patterns [similarities/repetitions] or bugs [errors] in these algorithms. AL, DL, M	use, modify and/or create algorithms by following a step-by-step process. Identify and recognise bugs in the algorithm and consider possible improvements. Explore how digital technologies operate according to precise instructions [specific actions in an algorithm that direct the process of solving a problem or completing a task]. AL, DL, M	build on the process of using, modifying and/or creating algorithms to solve a problem or achieve a desired outcome. Use abstraction [focus on important characteristics and reduce unnecessary detail] and debugging [identify and correct errors] to increase effectiveness or make improvements. AC, DL, M	create algorithms or programs [sets of instructions] to solve problems of interest or to represent solutions to real-world problems. Evaluate and share reflections on the process and/or solution. CL, DL, M
			appreciate the role that data plays in the digital world. Use at least one digital technology to generate/select, process and present data [information] that is relevant to their learning. CL, DL, M

Key competencies: AC = Being an active citizen; AL = Being an active learner; CL = Being a communicator and using language; C = Being creative; DL = Being a digital learner; M = Being mathematical; W = Being well

Learning Outcomes for Strand: **Engineering**

Stage 1 Junior and senior infants	**Stage 2** First and second classes	**Stage 3** Third and fourth classes	**Stage 4** Fifth and sixth classes
Through appropriately playful and engaging learning experiences, children should be able to:			
explore real and imagined design problems that are relevant to their lives. Communicate and share ideas about how these design problems might be solved. Plan and make a simple prototype to solve a design problem and reflect on the process they undertook. AL, C, CL	use empathy to identify design problems of interest to them. Plan and draft prototypes using a range of approaches and make prototypes of their preferred design solutions. Share and consider reflections and feedback on the design process. AL, C, CL	use empathy to consider user-needs, risks and limitations when identifying and researching design problems. Systematically plan, make, test and evaluate a design prototype to solve at least one of these problems. Make iterations and improvements based on reflections and peer feedback. AL, C, CL	working collaboratively, consider user needs when defining and refining design problems and solutions. Use sketching and traditional or digital tools to design plans. Make and test at least one prototype and evaluate the design solution. Draw conclusions and present an analysis of the iterative design process. AL, C, DL

Key competencies:

AC = Being an active citizen
AL = Being an active learner
CL = Being a communicator and using language
C = Being creative
DL = Being a digital learner
M = Being mathematical
W = Being well

6. The *Science, Technology and Engineering Education* Curriculum in Practice

The curriculum comes to life through learning, teaching and assessment, moving beyond the printed page to engage, inspire and empower children in their learning. *Science, Technology and Engineering* (*STE*) *Education* is underpinned by the vision, principles, key competencies and statements on learning, teaching and assessment in the *Primary Curriculum Framework*.

Every child deserves the opportunity to thrive and flourish in a supportive and engaging learning environment. The relationship between child and teacher is key to enabling this. The child is at the centre of the learning process and so an understanding of their prior learning, interests, experiences and knowledge is crucial for creating inclusive and appropriately challenging learning experiences. Learning in *STE Education* is improved by clearly identifying the focus of new learning, recognising ways for children to demonstrate their knowledge and understanding and designing a variety of learning experiences drawing on a range of pedagogical approaches.

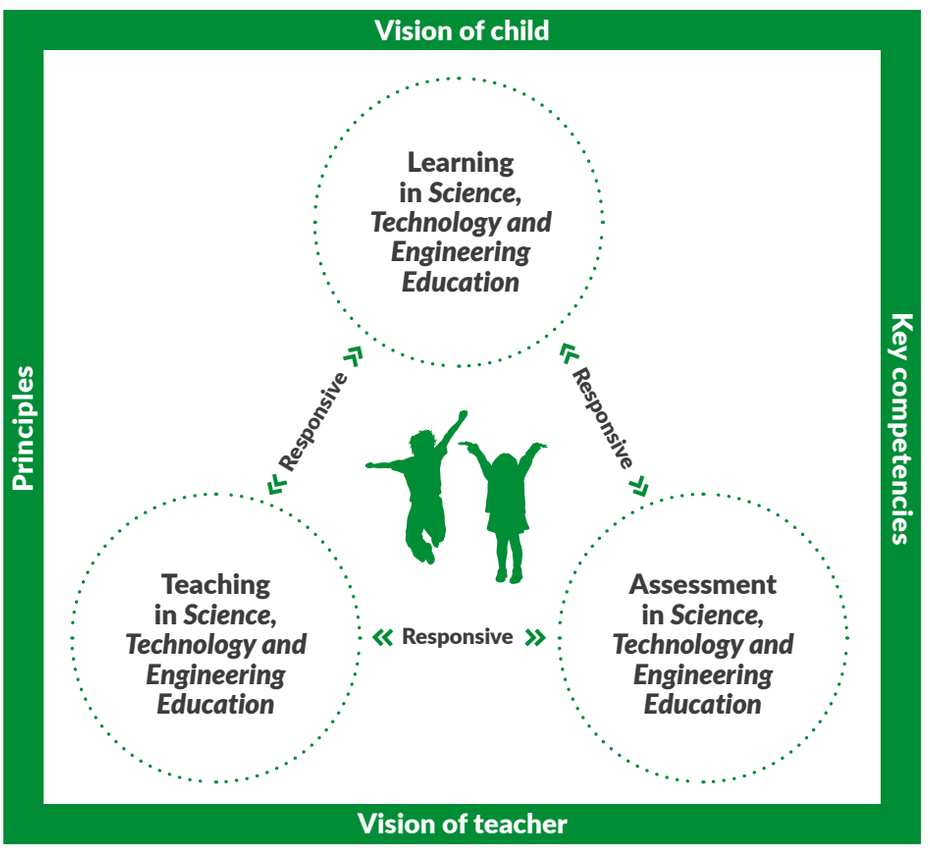


Figure 4: The *Science, Technology and Engineering Education* curriculum in practice

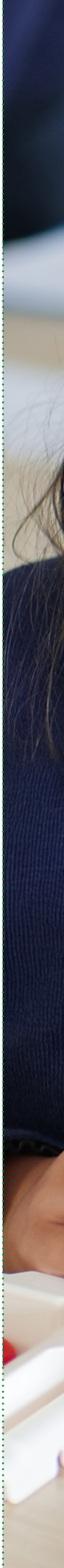
The remainder of this chapter outlines the main features of children's learning in *STE Education*, the pedagogical approaches that support and enhance it, and guidance in assessing children's learning and progression.

6a. Learning in *Science, Technology and Engineering Education*

Elements

In providing for playful and engaging learning experiences, it is essential to offer opportunities for children to engage with the elements of the *STE Education* specification.

Element	Examples within the *STE Education* specification
Exploring and understanding	• Asking a range of questions, making observations and inferences • Conducting research and a range of investigations in both indoor and outdoor learning environments • Connecting new learning with prior ideas and understandings • Exploring and using a diverse range of materials, tools and approaches • Organising and making sense of information gathered from relevant sources • Analysing information, interpreting results and making informed decisions • Being active and curious
Creative and critical thinking	• Taking time to brainstorm ideas individually and with peers • Considering diverse perspectives and alternative solution paths • Designing open-ended investigations and making creative plans • Making informed decisions and taking calculated risks • Considering and critiquing ideas for relevance and clarity • Considering safety, limitations and possible ethical considerations • Being open-minded and innovative
Applying and problem-solving	• Working collaboratively with peers in pairs, small groups and as a whole class • Creating, building and refining models and prototypes • Troubleshooting, debugging and modifying ideas and approaches, where appropriate • Selecting appropriate methods for collecting and recording relevant information • Developing and using a range of hands-on and practical skills • Being organised and persevering
Evaluating and communicating	• Learning and using appropriate STE language and terminology • Presenting ideas, methods and results in meaningful ways • Listening to and reflecting with others • Offering, reflecting on and responding to constructive feedback • Using evidence and reasoning to justify decisions, support arguments and draw conclusions • Evaluating the strength and effectiveness of ideas, solution paths and conclusions • Being logical and informed



Supporting children's learning in *Science, Technology and Engineering Education*

Each child is an individual with a unique set of strengths that need to be nurtured. Learning Outcomes provide the opportunity for all children to learn through multiple pathways supporting individualised and inclusive learning experiences. This is particularly important for children who have special educational needs.[1]

Additional Support Pathways outline different ways that children might engage with or demonstrate progression towards Learning Outcomes in *STE Education*. Using the pathways, teachers can consider the learning experience in greater detail and identify appropriate levels of challenge for children. In the course of their learning, children can be experiencing, attending, responding, initiating, acquiring, becoming fluent and generalising.

Although the pathways are listed sequentially, it is important to note that children may be engaging in each pathway at different times or simultaneously, depending on their diverse learning needs.

The following table describes seven pathways that may be useful for teachers to consider in preparing and providing for equitable opportunities for children to engage with and demonstrate progression in their learning in *STE Education*. For each pathway, an example is offered, however, examples are illustrative and represent just one of many possible ways a child might engage with and demonstrate their learning.

[1] The language used to describe educational needs and disabilities is evolving. For the purpose of clarity and to align with current policy and legislation, the term 'special educational needs' is used here.

Table 5: Examples of the Additional Support Pathways in *Science, Technology and Engineering Education*

Additional support pathway		Example in *Science, Technology and Engineering Education*
Experiencing	The child is present during a learning activity. They are exposed to and/or aware of the learning environment. They are beginning to acclimatise to aspects of the learning environment such as objects, people, sounds and other sensory experiences.	The child learns about relevant and important *STE Education* ideas through experiencing engagement with common natural and synthetic materials (e.g., wood, water, plastic) with a range of attributes (e.g., wet, cold, smooth) and through the use of multi-sensory learning tools and approaches.
Attending	The child becomes attentive to and/or engaged with the learning activities presented by changing gesture, posture, vocalisation, eye gaze, movement, etc. They are acclimatised to the learning environment.	The child focuses on the behaviour of materials in their environment, such as observing how water moves through a funnel or what sounds are produced when different materials are struck. Their focused attention is evident as they follow these interactions or sounds.
Responding	The child demonstrates capacity to actively or purposefully take an interest in the learning environment. They begin to indicate likes, dislikes or preferences. They actively respond to a learning activity with or without support.	The child notices plants, insects or rocks, actively pointing out and responding to certain features. The child responds more to particular parts of a STEM activity and displays curiosity towards objects or materials of interest.
Initiating	The child shows curiosity about the learning environment. They actively and independently seek opportunities to engage with and/or influence that environment.	The child demonstrates curiosity by independently picking up a magnet and testing which objects in their environment are attracted to it. They explore objects, seeking to playfully investigate them without direct instruction.
Acquiring	The child demonstrates that knowledge, a skill or a concept is being learned. They explore and participate in the learning.	The child explores the concept of sinking and floating by playfully experimenting with objects of different size, shape, weight and materials in water. They engage with learning activities and show curiosity and enthusiasm through hands-on exploration and play.
Becoming fluent	The child moves towards fluency and accuracy in familiar learning contexts. They independently and consistently demonstrate recall mastery of the knowledge, skill or concept learned.	The child applies their understanding of balance and weight distribution to building and rebuilding structures using STEM materials or blocks. The child consolidates their learning through repeated practice and successful problem-solving.
Generalising	The child transfers and applies learned knowledge, skills or concepts to familiar and unfamiliar contexts.	After learning how the height of a ramp affects the speed of a ball, the child predicts that a ball will roll faster down a steeper ramp, even if the ramp is made of a different material.

6b. Teaching in *Science, Technology and Engineering Education*

'How' children learn is as important as 'what' they learn in *STE Education*. Aligned with the principles of the *Primary Curriculum Framework* and reflecting the seven key competencies, this section outlines pedagogical approaches that are essential in the provision of playful and engaging learning experiences for all children. Taken together, they emphasise the importance of adapting teaching to the unique learning contexts in classrooms and schools. High-quality teaching values the diverse backgrounds, abilities, interests, strengths and needs children bring to the classroom. It aims to foster an inclusive, culturally responsive and engaging environment where every child feels safe, seen and valued. Positive relationships between children and teachers are essential, where children's voices are listened to and acted upon, fostering a sense of ownership in their learning. By maintaining high expectations for all children and providing appropriately challenging learning experiences, teachers can inspire confidence and enable each child to reach their potential.

The following pedagogical approaches are essential to the provision of meaningful learning experiences in *STE Education*.

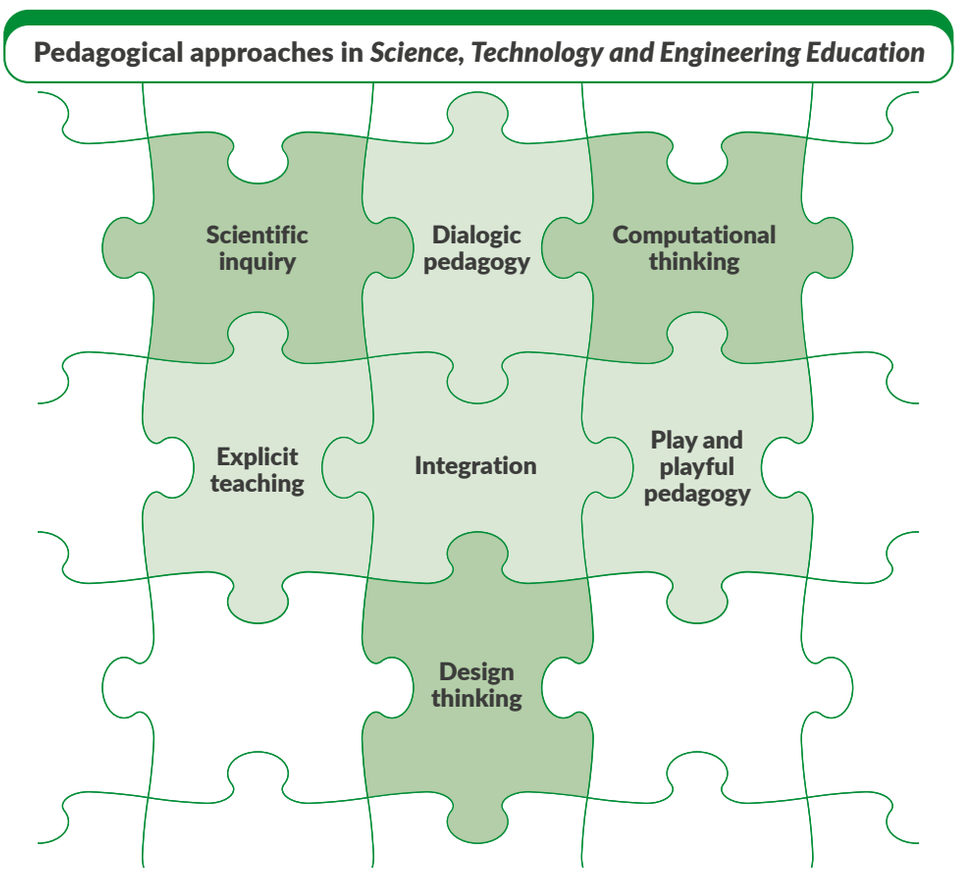
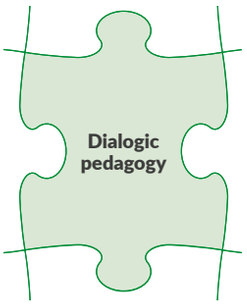


Figure 5: Teaching in *Science, Technology and Engineering Education*



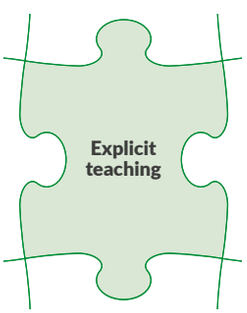
Dialogic pedagogy

Children learn through dialogue and interaction. Dialogic pedagogy is a collaborative approach where children and teachers address learning together, expressing and developing ideas and thinking. It involves all forms of communication between children and/or between child and teacher, fostering an inclusive environment where every child's voice is heard and valued. This reciprocal dialogue encourages exploration of complex ideas, critical thinking and informed decision-making, fostering a sense of agency.

When using dialogic pedagogy, the focus of learning must be clear to guide the dialogue. Children's thoughts build on each other, leading to new understandings. In the classroom, children feel empowered to contribute and have a say in their learning. A balance between teacher-guided and child-led dialogue enables deep engagement, facilitated by effective questioning, active listening and purposeful responses.

In *STE Education*, teachers can use dialogic pedagogy by:

- posing open-ended questions that require reasoning and critical thinking, facilitating collaborative discussions to brainstorm solutions and promoting the use of *STE Education* vocabulary
- encouraging children to engage in discussion and argumentation to justify and defend their thinking using evidence and logic and discuss the differences between observations and inferences, evidence and opinion
- conferencing with children to draw awareness to and elicit their use of *STE Education* skills, how they are applied and how they can be improved or refined
- facilitating discussion, debate and peer review when, for example, programming in pairs, evaluating scientific inquiries and/or refining prototypes.



Explicit teaching

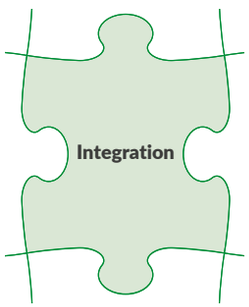
Explicit teaching enables the teacher to clearly share new knowledge, skills, concepts and language while modelling positive dispositions in a structured way. It should be considerate of children's developmental stages, their prior learning, abilities and needs. Through explicit teaching, the teacher demonstrates tasks or concepts by carefully modelling and scaffolding their own thinking, making the learning process transparent. Clear explanations, examples and demonstrations help support children's understanding. High levels of teacher-child interaction foster engagement, with questioning encouraging children to elaborate on their learning while staying interested, connected and motivated.

Guided and independent practice are crucial. Initially, children practise with teacher support and feedback, then gradually transition to independent activities to consolidate learning. The teacher ensures meaningful interaction and engagement for all children.

Timely, developmental feedback addresses misunderstandings and reinforces prior learning, guiding children towards new learning. This approach builds confidence and competence, ensuring active participation in learning.

In *STE Education*, teachers can use explicit teaching by:

- responding to 'teachable moments' to explore children's ideas, make connections in their learning and draw attention to important and relevant *STE Education* knowledge and skills
- describing and explaining a *STE Education* skill, the contexts in which it is useful and modelling and instructing how it can be applied in a variety of contexts
- using this pedagogy in contexts where active, practical or hands-on *STE Education* learning is not feasible or safe
- breaking down and organising complex or abstract ideas into more manageable and accessible units of learning. Clarifying what has been learned at the end of a unit of work to ensure solid understanding of *STE Education* concepts.



Integration

Integration reflects the interconnected nature of the world children experience daily. It provides opportunities to make connections within and across curriculum areas. Collaborating with children to identify ways to connect their learning to their lives fosters relevance and supports deeper understanding.

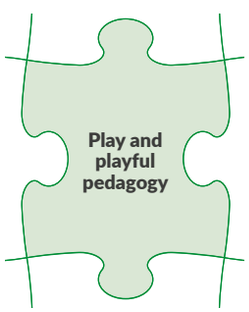
Integration dissolves traditional curriculum boundaries, creating cohesive learning experiences. For example, Content and Language Integrated Learning (CLIL) combines subject knowledge and language acquisition in meaningful, real-world contexts.

Teachers should purposefully anchor integration within the curriculum through the key competencies and Learning Outcomes, emphasising deeper understanding, innovation, critical thinking and engagement. Children's interests, cross-cutting themes, interdisciplinary skills, big ideas and real-world problems can provide effective starting points.

Integration explores topics from multiple perspectives, considering how key competencies contribute to holistic understanding and appreciation, and reflecting on how integration enhances and deepens these competencies.

In *STE Education*, teachers can use integration by:

- developing their own awareness of the interconnected nature of *STE Education*, as well as encouraging children to notice the intrinsic links between STEM and the wider world
- providing opportunities for children to engage in tasks, activities and projects that draw together concepts and skills from across STEM and other disciplines
- encouraging children to use technology to enhance their learning experiences and outcomes in *STE Education* such as when conducting scientific inquires or engaging in design thinking
- fostering children's awareness of how their scientific and mathematical knowledge can be applied to solve problems in Engineering and Technology, and similarly how STEM skills and processes can be applied across disciplines.



Play and playful pedagogy

Play is valuable throughout childhood, and children have both a right and desire to play. Play and playful pedagogies suit all stages within primary and special schools. Play encompasses a spectrum from child-led play to teacher-led playful activities and shared play where both teachers and children engage and develop the play together. This flexible approach allows for new learning opportunities.

Play promotes active and meaningful learning, connecting new information with existing knowledge. It supports holistic development, including physical, social, emotional, cognitive and spiritual growth, fostering skills like problem-solving, creativity and social interaction. Teachers should ensure that playful learning experiences are aligned with the Learning Outcomes of the curriculum, and with children's abilities, interests, strengths and needs.

A playful environment, indoors and outdoors, enhances learning by being interactive, engaging, inclusive and supportive, encouraging exploration, self-expression, choice and learning from mistakes.

In *STE Education*, teachers can use play and playful pedagogy by:

- being playful and enthusiastic in their own dispositions towards learning in *STE Education* and identifying learning experiences in both indoor and outdoor environments that evoke children's natural curiosities and inspire their imagination
- providing opportunities for multi-sensory, child-led playful experiences that support children's learning in *STE Education*, using stimuli such as images or story to initiate playful discussions and tasks
- providing a safe space to guide playful *STE Education* explorations and investigations that encourage spontaneity, creativity and informed risk-taking
- identifying where children can engage in hands-on and minds-on learning, where they have opportunities for exploring, making, tinkering and experimenting.

Scientific inquiry

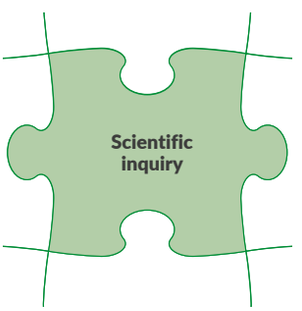
Scientific inquiry is an approach which emphasises children's active participation in Science in ways that mirror how scientists work in real contexts. Through a scientific inquiry approach, children build and strengthen scientific skills, scientific knowledge and their understanding of the Nature of Science. While scientific inquiries can initially be instigated and led by teachers, they should advance to be more guided and increasingly child-led. This can offer children greater opportunities for agency and decision-making.

Inquiry-based science is not a prescribed, uniform or linear process. As children progress through each stage, scientific inquiries can become more challenging, with children posing their own open-ended scientific questions, designing their own investigations and justifying their findings and conclusions. Gradually, children can engage in a variety of different types of scientific inquiries such as observation over time, pattern-seeking, identifying and classifying, fair testing and researching.

Planning for scientific inquiry should allow for creativity, flexibility and adaptability. For example, some inquiries may focus on making targeted observations, others may require a greater focus on data collection and some investigations may need to be carried out over weeks or months.

In *STE Education*, teachers can use scientific inquiry by:

- being open-minded and modelling a curious disposition about the world
- providing children with opportunities, materials and a safe environment in which to actively engage in scientific inquiry
- encouraging children to use their agency to choose scientific questions or challenges of interest to them and enabling them to discover new knowledge through their own investigations
- drawing children's attention to the scientific skills they are using and signalling how they are working 'like a scientist'
- encouraging children to apply their mathematical skills when gathering evidence, interpreting and analysing information, and reporting on the findings of scientific inquiries
- giving children opportunities to engage in different types of scientific inquiries and encouraging them to persevere when they encounter obstacles
- fostering a culture of collaborating and reflecting 'like scientists' in the classroom while emphasising the importance of evidence and reason in making scientific arguments
- encouraging children to notice and be alert to scientific discoveries, events or inquiries that are being conducted and reported locally and globally.



Computational thinking

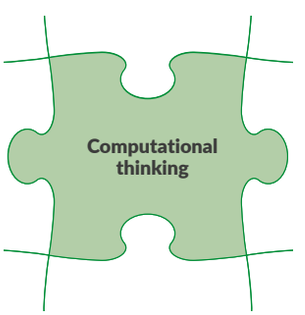
Computational thinking draws on the principles of computing to think about and solve problems. It involves the processes that we can use when considering and solving problems in a way that is similar to how computers assist us. When children develop their computational thinking, they can apply this learning across Science, Technology, Engineering and beyond.

Computational thinking encourages children to use logic and reasoning to break down problems into manageable parts, to apply prior knowledge to new contexts and to focus on important information relevant to the process of problem-solving. These skills are supported and strengthened by a range of dispositions that can be fostered through computational thinking. When used effectively, children can develop the confidence and persistence to work with challenging open-ended problems and can foster their ability to collaborate and communicate with others.

Computational thinking can be fostered through both unplugged [non-digital] and plugged [digital] learning activities in the classroom setting. While both unplugged and plugged activities are suitable for stages 1 to 4, it is essential to ensure that children have opportunities to transition from unplugged activities to plugged contexts. These activities may involve the design and development of algorithms or programs to solve problems and for a particular purpose.

In *STE Education*, teachers can use computational thinking by:

- providing opportunities for children to engage with both digital and non-digital technologies as users and creators
- broadening children's understanding of computational thinking as a problem-solving approach across *STE Education* and other curricular areas
- assisting children to decompose [break down] problems into a series of manageable steps and to abstract [remove] unnecessary detail
- modelling pattern recognition [spotting similarities and/or repetitions] and encouraging children to identify patterns that they have previously encountered in both unplugged and plugged activities
- facilitating children to systematically plan, design, create and modify algorithms [sequence of steps] in both unplugged and plugged activities, drawing their attention to the computational skills that they are using
- challenging children to test, modify and improve their creations in digital technology through working collaboratively with peers
- encouraging children to consider feedback, persevere in their explorations and to take informed risks as part of the process
- providing opportunities for children to reflect on the computational thinking process, evaluate their successes and setbacks and generalise their learning to wider contexts.



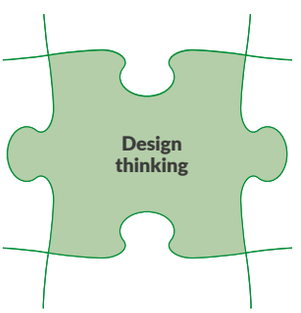
Design thinking

Design thinking is an action-orientated and practical process to support creative problem-solving and innovation. Design thinking approaches provide opportunities for children to collaboratively share knowledge, ideas and questions in authentic problem-solving contexts. It supports the development of meaningful research skills and critical thinking skills. Children actively engage in the process of solving design problems by generating questions, planning for and making prototypes and reflecting on the design process.

Design thinking emphasises the importance of considering different perspectives and approaches when viewing and solving problems. Opportunities to reflect on and consider the needs of others supports children's development of empathy and responsiveness. Design thinking encourages hands-on exploration and problem-solving through the processes of designing, creating, refining and evaluating. It fosters a mindset and disposition that is open-minded and adaptable. It encourages perseverance and creative risk-taking as children encounter challenges or setbacks in the design process. A design thinking approach follows a sequential yet flexible approach that may involve multiple iterations where children can move back and forth between steps and stages.

In *STE Education*, teachers can use design thinking by:

- promoting perseverance and a solution-focused attitude to learning and working on tasks and activities
- modelling empathy and perspective-taking and encouraging children to explore problems from the perspectives or viewpoints of others
- assisting children to select and research design problems that are of interest to them and relevant to their own lives
- providing opportunities for children to brainstorm and generate solutions to problems in pairs, groups and as a whole class
- facilitating children to engage in prototype design, bringing attention to the engineering skills that they are using and how they are working 'like an engineer'
- challenging children to plan, test and refine their prototypes through collaboration and deliberation
- encouraging children to be creative in their designs and to take informed risks
- providing opportunities for children to reflect on the systematic process of design and evaluate their successes and setbacks.



6c. Assessment in *Science, Technology and Engineering Education*

Every child has the potential to learn and thrive, and meaningful assessment is integral in nurturing this potential. As one of the eight overarching principles of the *Primary Curriculum Framework*, assessment is understood as a collaborative process, involving children, teachers, parents and, at times, other stakeholders. It involves an ongoing process of gathering, recording, interpreting, using and reporting information about a child's progress and achievement. Importantly, it provides an opportunity to gain insights into children's learning progress, to promote collaborative and self-reflection and to actively engage children in the assessment of their own learning.

Aligning assessment to the focus of learning

At the heart of education is the journey of each child's growth, and capturing rich portraits of their learning and progression over time is essential to this journey. Generally, assessment should directly relate to the focus of learning that children are pursuing at any given time through the Learning Outcomes of the *Science, Technology and Engineering Education* specification. Assessment often involves focusing on specific aspects of a Learning Outcome, rather than the entire outcome, to provide more focused insights into what children know, understand, or are able to do throughout a learning experience.

In the context of *STE Education*, assessment information can be used to monitor and support children's progress in understanding *STE Education* concepts and developing *STE Education* skills and to foster children's creativity and problem-solving abilities. It can help teachers identify areas where children need further support or challenge, inform adjustments to teaching strategies and guide future learning experiences that build on children's natural curiosity and critical thinking.

Opportunities for assessment in *Science, Technology and Engineering Education*

The curriculum supports a continuum of assessment ranging from 'intuitive' to 'planned interactions' to 'assessment events'. The three types of assessment are complementary and are necessary to gain a comprehensive picture of a child's progress and achievement in *STE Education*.

Table 6: Types of assessment

Intuitive assessment	Planned interactions	Assessment events
…occurs naturally and on an ongoing basis during learning experiences. It is integrated into pedagogy, can be invisible, yet still intentional to the teacher and is a very real part of the process.	…are a little more explicit and include practices such as having conversations with children, questioning, asking children to construct concept maps and following up on intuitive assessments or assessment events.	…differ from other types of assessment in that (1) they are distinct events, (2) they almost always involve producing a record of the outcomes of the assessment and (3) children are aware they are being assessed.

Gathering assessment information in *Science, Technology and Engineering Education*

Children will demonstrate their learning in many ways and through the use of a broad range of methods, teachers can gather rich information about children's learning in *STE Education*. Having a clear understanding of the information that is needed to build a picture of children's progress will support teachers to identify the most suitable methods to use. Below is a non-exhaustive list of methods likely to be useful in assessing children's progress in *STE Education* as they learn through the elements of Exploring and understanding, Creative and critical thinking, Applying and problem-solving and Evaluating and communicating.

Conferencing

Through teacher/child, peer/peer and group interactions, teachers can gain insights into children's communication skills, conceptual understanding and overall learning. Conferencing can enable teachers to evaluate both the process and the final product of learning experiences, offering specific, targeted feedback tailored to individual needs. Importantly, it fosters a positive, supportive and collaborative learning environment, shaping future learning experiences.

Feedback

Feedback is an integral part of the learning process, involving timely, constructive and focused interactions between teachers and children. It encourages reflection, recognition of progress and identification of next steps in learning. Feedback helps children critically analyse their learning, celebrate achievements and address challenges, guiding their future learning experiences.

Observation

Observations involve teachers actively monitoring, listening to and engaging with children during learning experiences. This method provides valuable insights into children's knowledge and understanding, enjoyment, engagement and interactions, enabling teachers to respond to opportune learning situations and guide further learning effectively. Teachers can notice how children develop skills, conduct inquires and problem-solve during learning.

Peer- and self-assessment

Peer- and self-assessment involve children reflecting on, sharing and discussing their learning with teacher support as appropriate. This method fosters self-reflection, collaboration and intrinsic motivation within an open, respectful and supportive learning environment.

Portfolios/Reflective STEM journals

A portfolio is a collection of a child's work, chosen and curated by the child and in collaboration with the teacher, reflecting their learning and development over a period of time. Portfolios and reflective STEM journals compile evidence of children's learning over time, supporting reflection, goal setting and self-assessment. They can be digital or physical, including various artefacts like images, videos, recordings, projects and samples of learning, demonstrating growth and progression in different curriculum areas.

Questioning

Questioning can involve posing well-crafted, open-ended and probing questions that elicit, support and deepen understanding, critical thinking and reflection. It encourages children to make connections, consider different perspectives and engage deeply with the learning process. In *STE Education*, questioning can also be helpful when identifying and refining problems/challenges.

Rubrics/shared success criteria

Rubrics involve the use of a coherent set of criteria for assessing children's learning which can be designed by teachers or created in collaboration with children. Rubrics can be particularly helpful in *STE Education* when assessing the knowledge, skills and dispositions that children use through the process of inquiry and problem-solving.

Tasks

Meaningful and relevant tasks provide opportunities for children to demonstrate their knowledge, understanding and skills in various ways. They can support authentic assessment, offering insights into children's learning in real-time situations and different contexts, indoors and outdoors. Tasks could include concept cartoons, concept mapping, collecting data and using digital or manual tools.

Documenting a child's learning is important. Purposeful use of documentation arises out of the process of gathering evidence. Children and teachers can use different ways to document assessment information, such as notes, photographs, videos and learning stories. Portfolios, as well as being an assessment method, offer a meaningful way to compile, organise, and showcase assessment information that reflects the child's authentic learning journey. Such documentation contributes to the rich, full picture of each child as they learn, progress and develop.

Using assessment information to inform next steps in children's learning

At the heart of effective learning is the meaningful use of assessment information. How assessment information is used will determine its overall effectiveness in supporting children's learning. Children's active involvement during assessment processes fosters a sense of ownership over their learning and can encourage self-reflection, critical thinking and growth. Effective feedback is crucial in the learning process, providing opportunities for children to reflect on their successes and progress.

A feature of high-quality teaching is the ability of teachers to respond to their unique classroom contexts by gathering, recording and analysing evidence to make informed judgements about children's progress and guide their learning and teaching decisions in *STE Education*.

These decisions are informed and shaped by:

- knowledge of the children and their prior learning
- knowledge of the curriculum
- knowledge of pedagogy.

Knowledge of the children and their prior learning

Children's prior learning, interests and experiences will shape their engagement and understanding in *STE Education*. Assessment facilitates the teacher's understanding of the child and their prior learning. This assessment information can guide teachers on how to use learning sequences or scaffolds which best support opportunities to build on and deepen children's knowledge, concepts and skills. Assessment methods, including questioning, using graphical representations such as concept cartoons and hands-on tasks can provide information on prior knowledge.

Knowledge of the curriculum

By engaging with the *STE Education* specification, teachers can reflect on children's learning experiences. As children work towards Learning Outcomes and deepen their learning in *STE Education*, assessment provides valuable information about children's progress. Using knowledge of the curriculum and the child's prior learning, teachers exercise agency to inform decisions about future learning in their classroom contexts.

Knowledge of pedagogy

By reflecting on the learning opportunities provided to children (as described in Section 6a) and the pedagogical practices enacted in the classroom (as described in Section 6b), teachers can adjust both the *STE Education* learning experiences and the *STE Education* learning environment. This serves to ensure that teachers are responding appropriately to children's learning. Collaboration with colleagues, professional learning and *STE Education* teaching resources provide further supports for teachers.

7. Outline of the Online *Science, Technology and Engineering Education* Toolkit

The online *Science, Technology and Engineering Education* Toolkit provides practical support for teachers in building rich learning experiences for children. The contents and components of the online toolkit evolve over time.

Examples of children's learning

Developed with teachers, these examples provide insights into how teachers work with Learning Outcomes to make decisions about what they teach, the types of activities, experiences and pedagogies they use and the information they gather on how well children are doing in their learning.

Support materials for teachers

The support materials include important resources and reference material to support teachers to enact the curriculum in a meaningful way. They have been developed in response to research and the evolving needs of children, teachers and school communities.

Supports for progression

Children learn and develop at different rates and this can look different across the curriculum areas and subjects. In response to research and the diverse range of children attending our primary and special schools, a range of supports have been developed to ensure all children progress in their learning and development.

8. Glossary

Abstraction	Abstraction is the process of filtering out and ignoring the characteristics of patterns or instructions that are not needed in order to concentrate on those that are.
Agency	Agency is the capacity to act independently and to make choices about teaching and learning.
Algorithm	An algorithm is a set of instructions and steps to create solutions to problems.
Argumentation	Argumentation is the dynamic process of constructing, evaluating and defending evidence-based claims made in Science and STEM.
Biodiversity	Biodiversity refers to the variety of living things, such as plants, animals and insects, and how they all work together in different habitats and larger ecosystems.
Biology	Biology is the study of the living world.
Chemistry	Chemistry is the study of matter/substances and the changes it/they can undergo.
Computational thinking	Computational thinking is the process that we use when considering and solving problems in such a way that computers can assist us.
Conductor	A conductor is a material/substance that allows heat or electricity to flow through it.
Conservation	Conservation is the prevention of wasteful use of resources, including the preservation and protection of the natural environment and of wildlife.
Data	Data is a collection of information or facts, such as numbers, words, measurements, observations or other descriptions. Computer data is information in a form that can be processed by a computer.
Debugging	Debugging is the process of checking and fixing errors in a program. A mistake or error in an algorithm or computer program is called a bug.
Decomposition	Decomposition involves breaking down of a problem, into several parts or components, to make the problem-solving process more manageable and efficient.
Design problem	A design problem is an open-ended problem that identifies a challenge, a question or a need.
Digital tools	Digital tools include devices, web browsers, software and other digital technologies.
Digital system	Digital systems are different parts of hardware and software components that work together to enable a system to function. Digital systems work by receiving, processing and outputting data.
Ecosystem	An ecosystem refers to a community of living organisms, such as plants and animals, interacting with each other and their physical environment in a specific area.
Electric circuit	An electric circuit refers to the complete path of an electric current around a series of wires and connections; if there is a break in the circuit the current will not flow.
Empathy	Empathy involves perspective-taking, understanding, being aware of, being sensitive to, and sometimes vicariously experiencing the emotions, feelings, thoughts, and experiences of another.
Emerging technologies	Emerging technologies refer to novel and rapidly changing technological innovations that have the potential to impact and transform aspects of society.
Energy	Energy can be defined as the ability to cause change and may be recognisable in different forms such as sound and light.
Environment	An environment refers to the surroundings, natural and man-made, where plants, animals and humans live together.

Evidence	Evidence refers to the available body of facts or information indicating whether a proposed explanation is valid or trustworthy.
Fair test	Fair tests are scientific investigations that endeavour to answer testable questions. In a fair test only one variable is changed, and all other conditions remain the same.
Food chain	A food chain is the order in which organisms (living things) depend on each other for food.
Force	A force is an interaction that changes the motion of an object if unopposed. Force is loosely understood as being a push or a pull. It can make an object speed up, slow down, stop, change shape or change direction or can hold an object in place.
Friction	Friction is a force that opposes movement.
Gravity	Gravity is a force of attraction between all bodies in the universe. The force of attraction between objects depends on their mass; the greater the mass of an object the greater the force of attraction.
Habitat	A habitat is a place where an organism lives. It provides a particular set of conditions for life and it may be large (a field) or small (a leaf).
Hands-on and minds-on learning	Hands-on and minds-on learning involves engaging in higher-level thinking and active learning.
Human system	A human system is groups of organs and tissues that work together to perform an important function of the human body.
Imagined problem	An imagined problem refers to a hypothetical or fictional problem created for the purpose of simulating an engaging learning experience of interest. Imagined problems can be inspired by stories, children's play, observed activities or from children's own ideas or wonderings.
Inference	An inference is a conclusion reached based on evidence and reasoning.
Innovation	Innovation is the creation and use of new ideas and/or methods.
Input	An input is the information or instructions provided to a digital or non-digital technology.
Insulator	An insulator is a material/substance that does not allow heat/electricity to flow through it.
Interdependence	Interdependence is the idea that everything in nature is connected to and depends on other things.
Iterations	Iterations are changes that are made to a design or a process to improve its use and effectiveness.
Magnification	Magnification is the apparent enlargement of an object by an optical instrument.
Mass	Mass is the measurement of how much matter is in an object.
Matter	Matter is anything that takes up space and has mass. Solid, liquid and gas are terms used to describe the three states of matter.
Nature of STEM	Nature of STEM refers to what STEM is, how it works and how it relates to the world around us.
Non-renewable energy	Non-renewable energy refers to energy that is made from something that gets used up, for example energy from coal or oil.
Observation	An observation involves using the senses to obtain information about objects and events.
Output	An output is the result produced by the information or instructions provided to a digital/non-digital technology.

Physics	Physics is the study of the nature and properties of matter and energy.
Plugged activities	Plugged activities engage children in the process of computational thinking and computing with the use of digital technologies.
Precise instructions (Digital technologies)	Precise instructions refer to specific actions in an algorithm that direct the process of solving a problem or completing a task.
Process (Digital and non-digital technologies)	A process refers to digital/non-digital technology using the information or instructions provided by the input to make something happen (output).
Programming	Programming is the process of writing instructions (algorithms) in a language that a program on a digital tool can follow.
Properties of materials	Properties of materials refer to the features of materials that enable us to compare and contrast materials.
Prototype	A prototype is an early sample or a first draft of a design/creation which can be adapted.
Real-world problem	A real-world problem refers to a problem that is generated from children's real-world experiences. Real-world problems could be identified from children's local environment, their personal experiences/interests or the news.
Reflection	A reflection is a ray of light that hits off something and bounces back. All objects reflect light to some extent, some better than others. For example, a mirror reflects light very well.
Refraction	Refraction is the change of direction of light when it passes from one transparent medium to another, for example, from air to glass, water or plastic.
Renewable energy	Renewable energy refers to energy that is made from something that doesn't get used up, for example, energy from wind, sun and water.
Resilience	Resilience is the ability to adapt and navigate through challenges, setbacks, or difficult situations.
Scientific inquiry	Scientific inquiry refers to the range of ways in which scientists investigate and study the world and propose explanations based on evidence.
Spectrum (visible)	A spectrum is the range of colours produced when light is passed through a prism.
STEM eyes	STEM eyes refer to looking at the world through the perspective of Science, Technology, Engineering and Mathematics (STEM).
Sustainability	Sustainability is the responsible use and preservation of resources to meet the needs of the present without compromising the ability of future generations to meet their own needs.
Teachable moments	Teachable moments occur where a teacher identifies that children would benefit from a short pause during a lesson to focus on the acquisition of specific and/or targeted disciplinary knowledge, skills or perspectives that can deepen and enhance their overall learning experience.
Technologies (digital and non-digital)	There are both digital and non-digital technologies. Examples of digital technologies include computers, smartphones and digital clocks. Examples of non-digital technologies include pens, paperclips and mechanical clocks.
Testable question	A testable question is a question that can be investigated by experimental inquiry.
Tinkering	Tinkering refers to exploring and trying different hands-on approaches to support understanding and problem-solving in Engineering and Technology.
Unplugged activities	Unplugged activities engage children in the process of computational thinking and computing without the use of digital technologies.

9. References

Department of Education (2023). *Primary Curriculum Framework*. Dublin: Department of Education. Available at: **https://curriculumonline.ie/primary/the-primary-curriculum-framework**

Department of Education and Skills (2015). *Framework for Junior Cycle*. Dublin: Department of Education and Skills. Available at: **https://ncca.ie/media/3249/framework-for-junior-cycle-2015-en.pdf**

Government of Ireland (2024). *Aistear: the Early Childhood Curriculum Framework*. Dublin: Government Publications. Available at: **https://curriculumonline.ie/Early-Childhood**

National Council for Curriculum and Assessment (2009). *Aistear: the Early Childhood Curriculum Framework*. Dublin: NCCA. Available at: **https://curriculumonline.ie/Early-Childhood**

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An Approach to Integrated STEM Learning

Bridging Science, Technology and Engineering Education and Mathematics Education

Integrated STEM Learning

Integrated STEM learning enables children to connect their learning across Science, Technology, Engineering and Mathematics and to apply this to real-world and imagined contexts. The *Primary Mathematics Curriculum* and the *Science, Technology and Engineering Education* specification have been developed with integrated STEM learning in mind. They provide an opportunity for dedicated time and space for children to engage in integrated STEM and opportunities where they can apply, reinforce and consolidate the knowledge and skills they have acquired from their learning.

This section includes:

- Overarching statements on integrated STEM
- Phases of integrated STEM learning
- Supporting children's engagement in integrated STEM learning
- Connecting STE+M at a glance

Overarching statements

The following overarching statements set an important context for integrating learning experiences across the STEM subjects and the benefits this offers children in their learning and their lives, both in and outside of school.

Table 1: Overarching statements for integrated STEM learning

Integrated STEM	Overarching statements
STEM literacy	Children enhance their STEM literacy through opportunities to connect and apply knowledge of STEM in practical and meaningful ways to inform decision-making and contribute to active citizenship.
Active problem-solving	Children become active problem-solvers through opportunities to investigate and solve problems that require them to draw on and apply existing knowledge and skills associated with STEM.
STEM with a conscience	Children develop ethical and responsible approaches to STEM by negotiating the impact of STEM endeavours for society, the environment and the planet; striving for improvement and sustainability.
STEM mindset	Children develop a STEM mindset and dispositions through learning experiences where they can look at the world with STEM eyes and consider alternative perspectives on how discoveries can be made and problems can be solved. This empowers them to think in new and beneficial ways.

Phases of integrated STEM learning

The following approach to integrated STEM learning outlines five phases that are useful to consider when guiding and supporting children's learning. It should be used flexibly and adapted to bespoke contexts. The five phases are as follows:

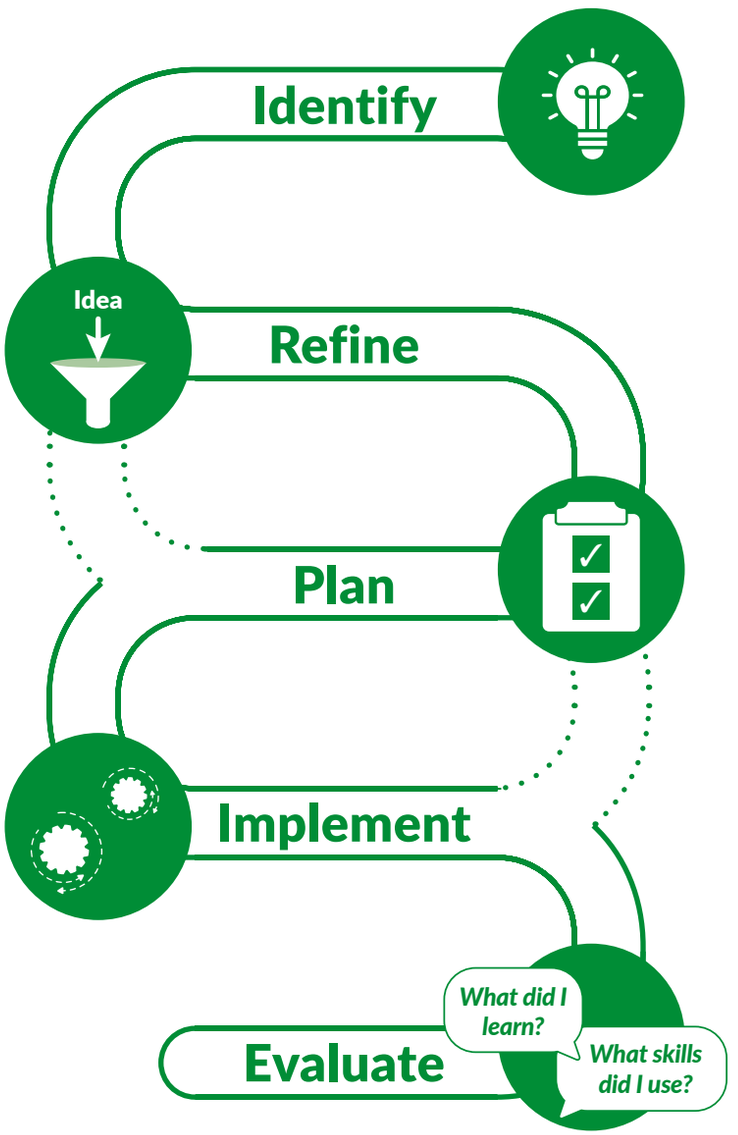

Figure 1: Phases of integrated STEM learning

Identify

Children generate questions of interest on topics that have relevance to their lives or to the lives of others. They can do so initially by exploring their wonderings on the topic, e.g., "I wonder ..."

Refine

As children become more attuned to using their STEM eyes, they can assist the teacher to refine the identified problem or challenge to ensure that it is manageable and feasible for their particular context. Over time, children can practise and gain confidence to refine problems or challenges themselves.

Plan

Children develop a plan or design to approach the problem or challenge and can draw on a range of planning approaches, e.g., using digital tools or sketching. Plans can be modified and refined throughout the task or activity. As children become familiar with a range of STEM processes, they can decide which process is appropriate for the task or activity.

Implement

Children implement their plans to address the question or challenge using hands-on and minds-on learning (as described in Section 6a).

Evaluate

Children present results, key learning and reflections from their engagement in the STEM task or activity, in ways that are meaningful to them and suitable for their audience.

Supporting children's engagement in integrated STEM learning

Integrated STEM learning begins with the children's own interests, questions and wonderings. These spark the learning task, challenge or problem that children engage with, ensuring that it is meaningful and child-led. The teacher's role is to support and scaffold the process, helping children explore, investigate and deepen their understanding over time. As children engage with tasks, the teacher highlights the STEM knowledge and skills they are using. Where challenges arise or gaps in understanding are identified, the teacher can respond to these 'teachable moments' to support and ensure learning progression, always encouraging children to take the lead in their own discovery and problem-solving.

The following prompts may be useful for teachers to consider when supporting children's engagement in integrated STEM learning across each of the five phases.

To **identify** the focus of an integrated STEM activity or task, the following questions can be considered by the teacher:

1. What problem or challenge is of most interest or relevance to the child?
2. What prior knowledge/topics can children draw on, consolidate and apply to help address a problem or challenge? [See Tables 2 and 3 in this section]
3. What new skill(s) can be developed or strengthened during the process? [See Table 4 in this section]

To **refine** the focus of the integrated STEM activity or task, the following questions can be considered by the teacher:

1. How might the detail of the question or challenge be adjusted so that it is more accessible, manageable or appropriately challenging?
2. What additional detail could be woven into the task or activity to promote further integration? For example, measuring or pattern identification.
3. What equipment and resources will be necessary to address the question or challenge?
4. What safety issues, risks or environmental considerations may arise?

To **plan** or design, the following questions can be considered by the teacher:

1. What will the plan or design look like? What format will it take and how will it be communicated to others?
2. What key steps are required to tackle the problem or challenge?
3. What potential obstacles might be encountered? How can these be addressed?

To **implement** the plan or design, the following questions can be considered by the teacher:

1. What opportunities are there to engage in essential learning as described in Section 6a?
2. What opportunities are there for children to lead and direct their own learning journey as they engage in the task or activity?
3. What opportunities are there to draw children's awareness to how the skills, knowledge and perspectives they are using in this task relate to those used in real-world STEM contexts?

To **evaluate** their learning, the following questions can be considered by the teacher:

1. Can the children identify key learning from the task?
2. What aspects of the task or activity worked well/not so well?
3. What knowledge and skills were critical in approaching the problem or challenge?
4. Reflecting on how the problem or challenge was approached, would the same approach be selected again? If not, what could be done differently?
5. What questions, problems or challenges remain? Can they be investigated further?

Connecting STE+M at a glance

The following tables provide an overview of topics and skills across both the *Science, Technology and Engineering Education* specification and the *Primary Mathematics Curriculum* at a glance. They can be used to make curriculum links when identifying and refining STEM questions and challenges.

They also offer a useful reference for identifying the prior knowledge and skills that children could draw on, consolidate and apply to help address a STEM problem or challenge. It is important to note that the content of these tables is not exhaustive.

Table 2: Topics across strands in the *Science, Technology and Engineering Education* specification

Nature of STEM	Living things	Materials	Energy and forces	Technology	Engineering
STEM in our world	Human life	Materials and the world	Energy and the world	Understanding technology	User-focused design
How STEM works	Plant life	Properties of materials	Forms of energy	Using technology	Knowledge of design process
	Animal life	Materials and change	Sustainable energy	Creating with technology	
	Nature and the outdoors		General forces		
	Biodiversity		Forces and their impact		

Table 3: Strands and strand units in the *Primary Mathematics Curriculum*

Algebra	Data and chance	Measures	Number	Shape and space
Patterns, rules and relationships	Data	Measuring	Uses of number	Spatial awareness and location
Expressions and equations	Chance	Time	Numeration and counting	Shape
		Money	Place value and base ten	Transformation
			Sets and operations	
			Fractions	

Table 4: Skills across *Science*, *Technology*, *Engineering and Mathematics*

Science **S**TEM	Technology S**T**EM	Engineering ST**E**M	Maths STE**M**
• Scientific questioning • Investigating • Observing • Inferring • Predicting • Classifying	• Identifying patterns • Decomposing • Sequencing (Algorithmic thinking) • Abstracting • Debugging	• Sketching • Prototyping • Testing • Making (Constructing) • Perspective-taking • Iterating	• Mathematising • Justifying • Representing • Generalising • Connecting • Mathematical modeling • Estimating and measuring
Transferable skills across STEM Planning, Exploring, Analysing, Data handling, Reasoning, Recording, Evaluating, Communicating, Argumentation, Presenting, Applying and Using digital and non-digital technologies			

There are a range of tools in the online *STE Education* and Primary Mathematics Toolkits to assist teachers to enable and support integrated STEM learning.

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Primary Mathematics Curriculum

For Primary and Special Schools

1. Introduction

The primary curriculum supports high-quality learning, teaching and assessment for all children attending primary and special schools. The curriculum recognises primary education as a time of 'being' and 'becoming' – highlighting the importance of interesting, relevant and appropriately challenging experiences. It is important that children enjoy and benefit from these experiences in the present, whilst simultaneously equipping them for learning in the years ahead. The primary curriculum is premised on a vision of children as unique, competent and caring individuals. It aims to provide a strong foundation for every child to thrive and flourish. It supports children in realising their full potential as individuals and as members of communities and society during childhood and into the future. This takes place through high-quality learning, teaching and assessment that is inclusive and responsive.

The primary curriculum acknowledges that from birth, children begin their educational journey through interactions and experiences with the world around them. In primary and special schools, children engage in playful and engaging learning experiences that build upon the knowledge, skills and dispositions they have acquired at home and in preschool settings through *Aistear: the Early Childhood Curriculum Framework*. As children progress through primary and special school their learning connects with, and is further progressed through, the learning experiences provided in Junior Cycle. Each child's learning journey is different, and so the curriculum provides flexibility and choice to teachers and school leaders as they support children in their holistic development.

Principles of learning, teaching and assessment

The following principles, as outlined in the *Primary Curriculum Framework*, convey what lies at the heart of primary education, including children's learning of Mathematics.

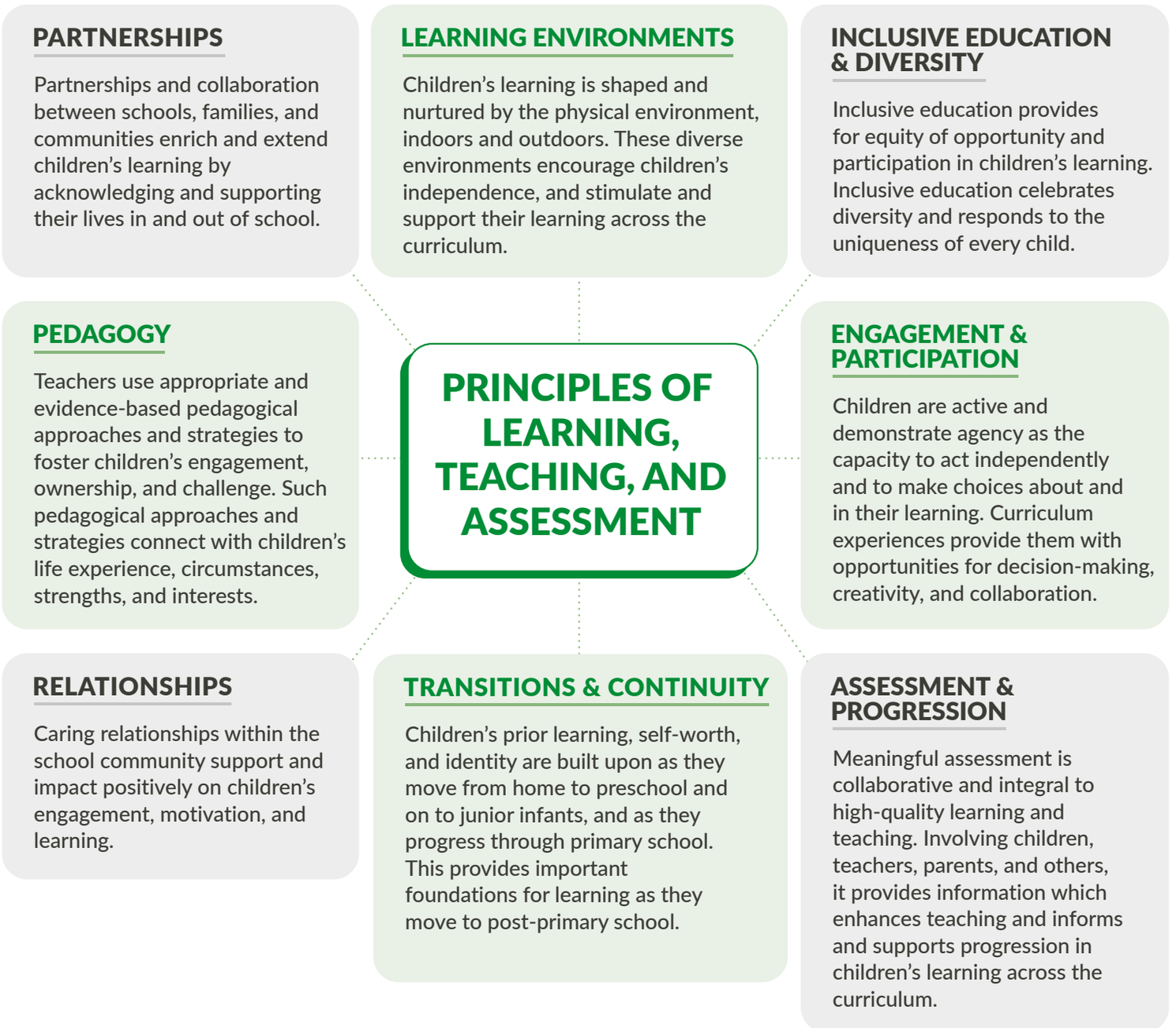


Figure 1: Principles of learning, teaching, and assessment

Children's mathematical learning experiences

In the primary curriculum, Mathematics is situated within the *Science, Technology, Engineering and Mathematics (STEM) Education* curriculum area. Mathematics provides an important foundation upon which to develop and refine children's learning in *STEM Education*. Rich learning experiences in *STEM Education* help children to understand relationships, connections and patterns, and to engage fully with the world around them.

The primary curriculum has seven key competencies which overlap and combine to support the curriculum's vision. As outlined in the *Primary Curriculum Framework*, the competencies build on the capabilities children acquire through their early childhood education experiences with *Aistear: the Early Childhood Curriculum Framework*; and are further strengthened in post-primary school in Junior Cycle. As children work towards the Learning Outcomes in the Mathematics curriculum and engage in rich mathematical learning experiences, they simultaneously build and develop the key competencies.

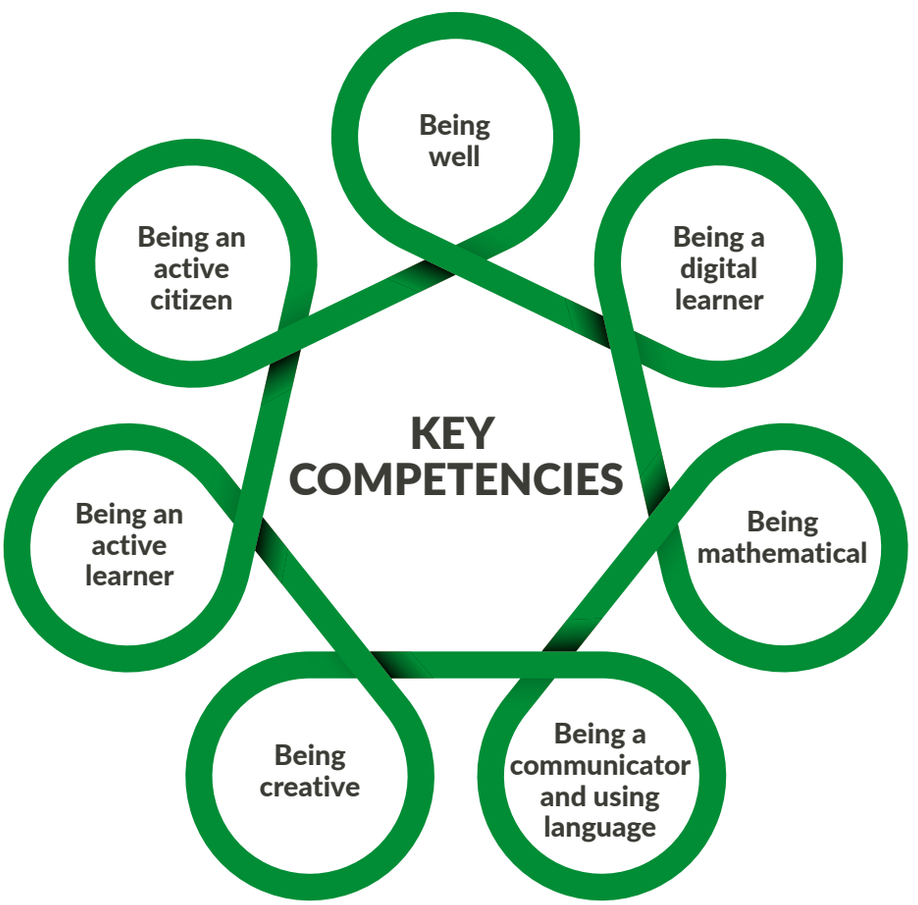


Figure 2: Key competencies

Table 1: Examples of attributes of each key competency developed through learning in Mathematics

Key Competency	Examples of attributes developed through learning in Mathematics
Being an active citizen	• Applying mathematical knowledge and skills to solve real world problems • Using Mathematics to generate and manage information that informs and promotes a critical understanding of the world and society
Being creative	• Exploring Mathematics with curiosity, open-mindedness and imagination • Investigating, using and sharing diverse mathematical ideas and solution paths
Being a digital learner	• Using a range of digital technologies to expand how to engage with, express and represent complex mathematical ideas • Reducing complexity and allowing for the development of higher-order thinking
Being mathematical	• Framing real world information and situations in mathematical terms • Engaging in mathematical activities that involve enjoyment, effort, risk-taking, critical thinking and reflection
Being a communicator and using language	• Expressing thinking using mathematical language, signs and symbols • Sharing and comparing ways of representing mathematical thinking and ideas
Being well	• Developing and contributing unique perspectives and ideas about mathematical situations • Applying Mathematics in meaningful contexts and experiencing learning success
Being an active learner	• Persevering with complex mathematical problems and tasks • Reflecting on and evaluating approaches and solutions to mathematical tasks

Overview of the Mathematics curriculum

The opening sections of the *Primary Mathematics Curriculum* present the Rationale, Aims, Strands and Elements, and Learning Outcomes. Chapter 6 provides guidance on the curriculum in practice, while the final chapters provide an overview of the Primary Mathematics Toolkit and a glossary of terms.

The *Primary Mathematics Curriculum* is supported by the Primary Mathematics Toolkit. It contains a range of supports for enacting the curriculum, such as mathematical concepts, progression continua, support materials and examples of children's learning.

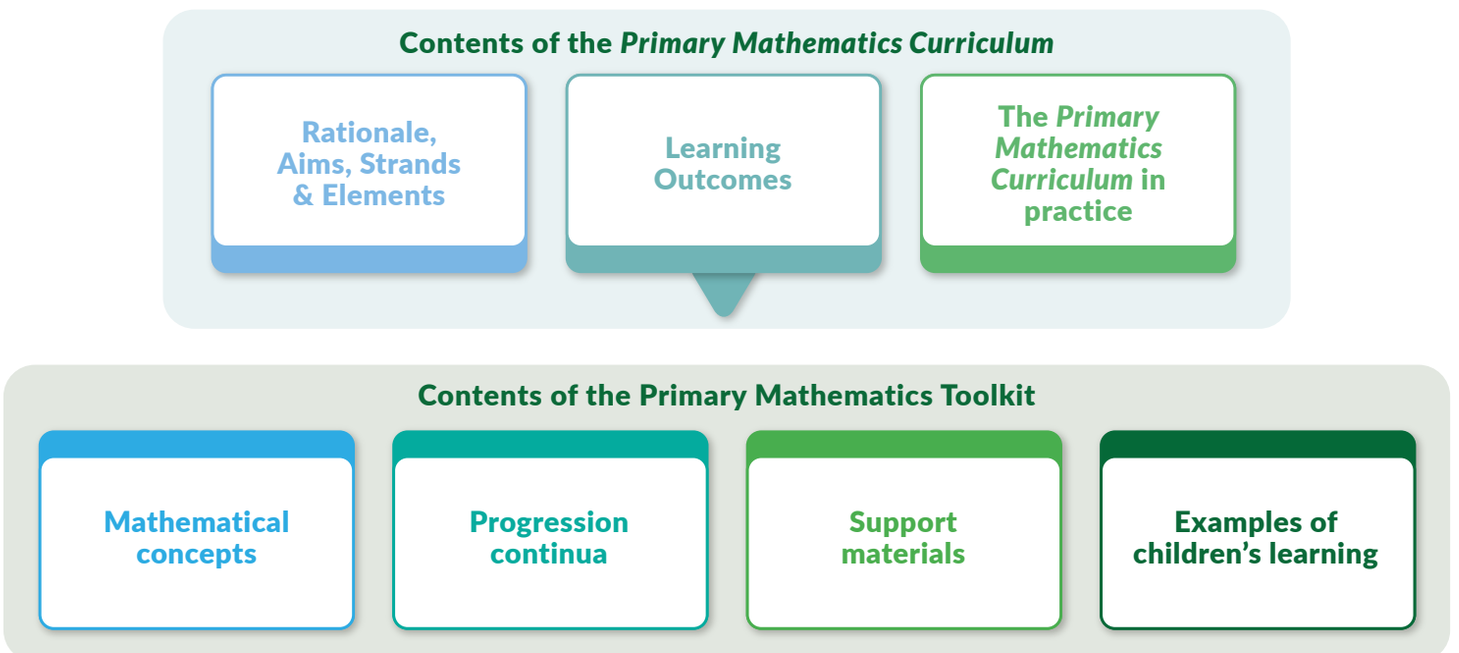


Figure 3: Overview of *Primary Mathematics Curriculum* and Toolkit


10+810
6+4=
LIQUID CHALK
WINDOW MARKER


+5=10
1+5=6

2. Rationale

Learning Mathematics

Mathematics is the study of the relationships, connections and patterns that surround us, and is thus intrinsic to our concept of the world. Mathematics greatly enhances our capacity to understand and engage fully with the world around us. A child's mathematical learning journey begins from birth. Children initially learn Mathematics through their interactions and experiences in their home environment. They later build on this learning through early childhood, primary, special and post-primary education.

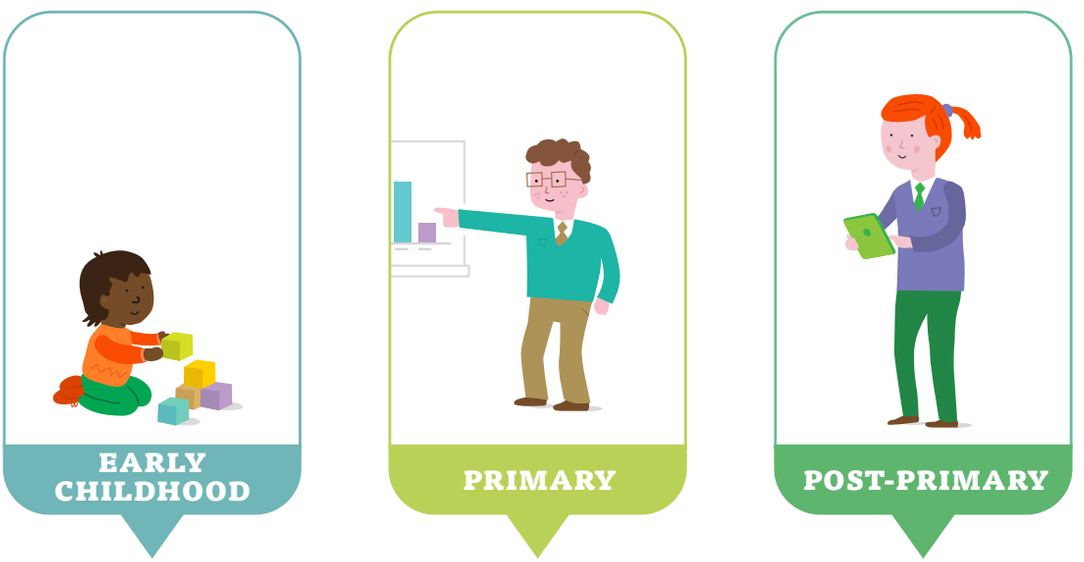


Figure 4: Building on children's learning in Mathematics

Every child is mathematical

Every child has an innate, intuitive and instinctive sense of Mathematics. Every child is capable of engaging with mathematical concepts and ideas from birth, and deepening and developing their learning over time.

Primary mathematics education evokes children's innate ability to think and communicate mathematically, to solve problems and to make sense of the world using Mathematics. Children are encouraged and supported to have a positive disposition to Mathematics and to develop their mathematical understanding, language, communication skills, perseverance and resilience, interactions and expressions.

Mathematics is both a human and social phenomenon

Mathematics learning is dependent on social and cultural experiences as well as on children's educational experiences in school.

Primary mathematics education provides children with playful and engaging learning experiences that promote mathematical thinking, such as modeling, thinking aloud and maths talk. It also provides opportunities for children to collaborate, communicate mathematical thinking and express their understanding in multiple ways and in various contexts.

Mathematics is a tool that helps us to make sense of our world

Mathematics is used to think about, see and organise our everyday lives and the world. Primary mathematics education equips children with mathematical, statistical and financial literacy skills and tools. It helps them to better function in, critically engage with and navigate the world around them. It also enables children to develop the language of Mathematics so that they can communicate and solve problems using Mathematics.

Mathematics is beautiful and worthy of pursuit in its own right

It is important that children have the opportunity to engage with Mathematics as a discipline in its own right and to explore its many intriguing aspects. Through playful, creative and engaging learning opportunities, children can experience the beauty and power of Mathematics. Primary mathematics education fosters a love of Mathematics. It provides children with the opportunity to explore, discover and refine their ideas. Children are supported to think critically and flexibly, and to be creative and innovative in their approach to learning Mathematics.

Mathematics is everywhere and for everyone

Mathematics is a human activity that develops in response to everyday problems and interactions. Primary mathematics education provides children with opportunities to engage with appropriately rich, meaningful and challenging Mathematics in educational settings, including social and familial settings. Such engagement results in children co-constructing knowledge and skills as they interact and collaborate to solve real and complex problems.

3. Aims

The over-arching aim of the *Primary Mathematics Curriculum* is the development of mathematical proficiency. Mathematical proficiency encompasses conceptual understanding, procedural fluency, adaptive reasoning, strategic competence, and productive disposition. Importantly, all five aspects are interwoven and interdependent.

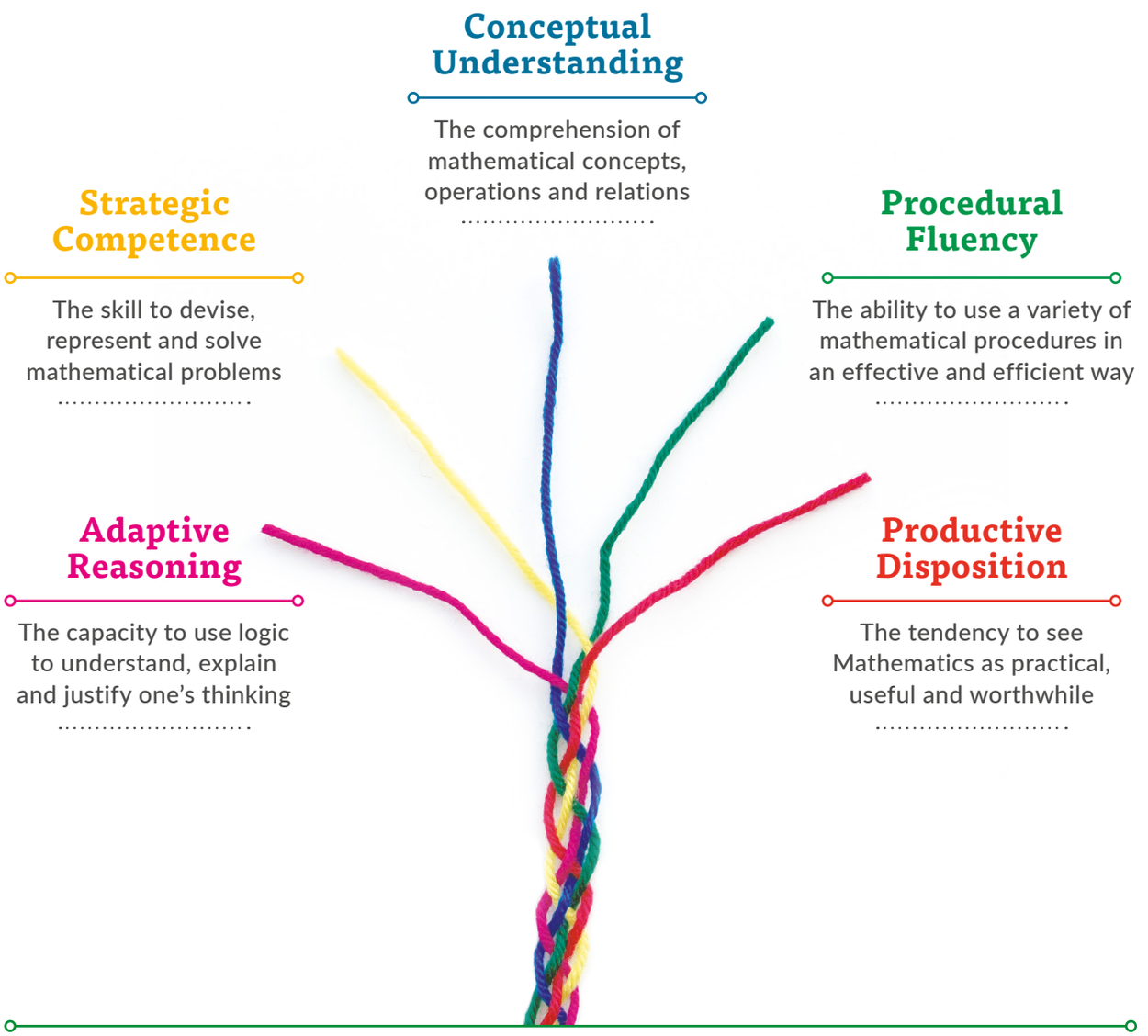


Figure 5: Five aspects of mathematical proficiency

4. Strands and Elements

Strands

Strands outline the main categories of mathematical learning (what children learn) across five domains or content areas of primary mathematics: algebra; data and chance; measures; number; and shape and space. Each strand has a set of strand units.

Table 2: Strands and strand units

Algebra	Data and chance	Measures	Number	Shape and space
Patterns, rules and relationships	Data	Measuring	Uses of number	Spatial awareness and location
Expressions and equations	Chance	Time	Numeration and counting	Shape
		Money	Place value and base ten	Transformation
			Sets and operations	
			Fractions	

Elements

Elements describe the main categories of processes (how children learn) that children engage in as they learn Mathematics. These processes include: connecting, communicating, reasoning, justifying, representing, problem-solving, generalising and argumentation, and are categorised into four elements: understanding and connecting; communicating; reasoning and applying; and problem-solving. These are central to the development of children's mathematical proficiency.

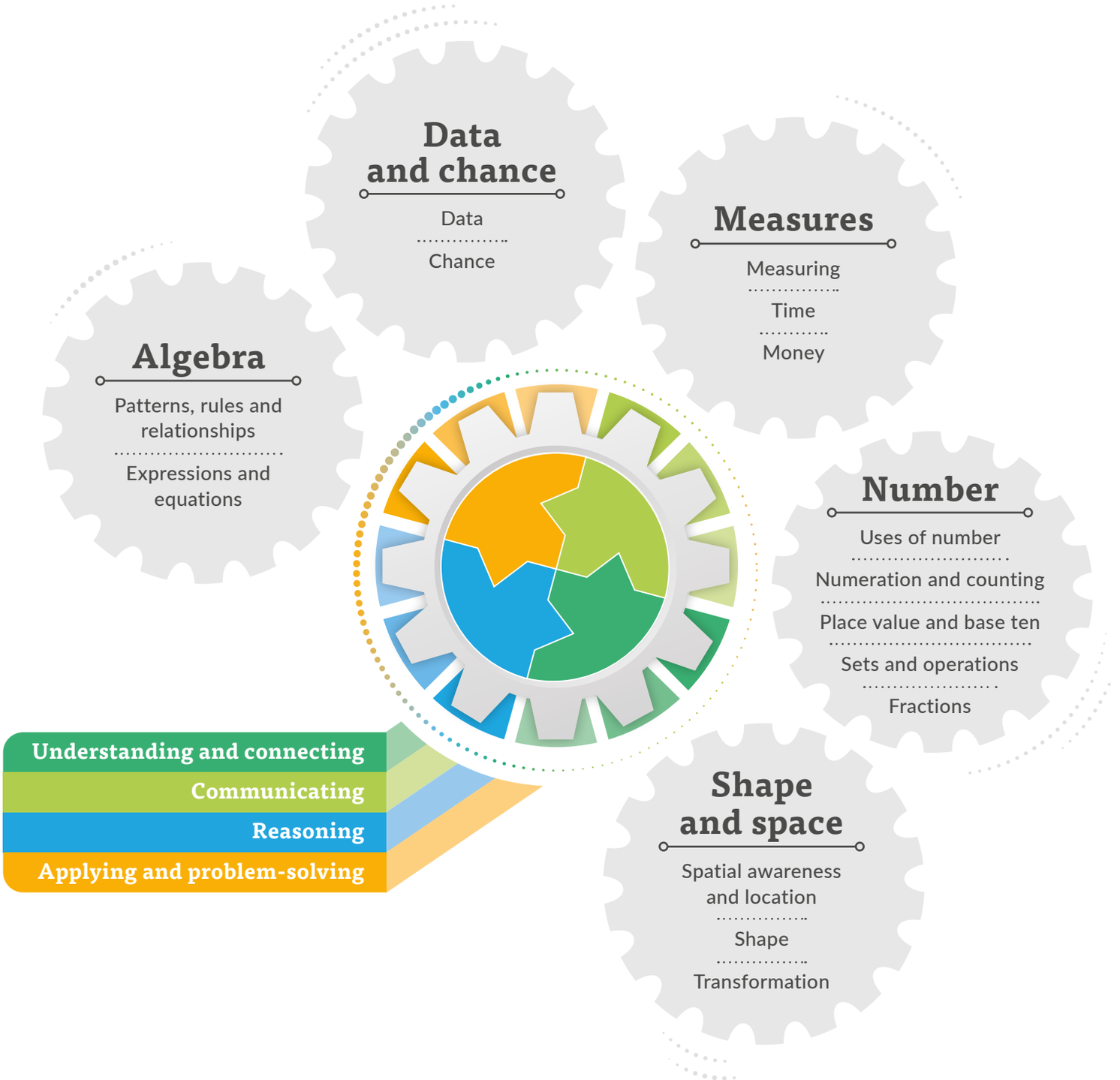


Figure 6: The strands and elements of the *Primary Mathematics Curriculum*

Element 1: Understanding and connecting	Children make connections between related concepts and procedures—the 'why' and the 'how' of Mathematics—and between new and prior knowledge, in order to make sense of what they are learning. They apply and connect their understanding to contexts within Mathematics, with other areas of learning and with the real world.
Element 2: Communicating	Children use appropriate language and/or means of communication and a variety of representations and conventions to convey thinking, ideas, relationships and logical arguments. They improve and refine their thinking and communication through engaging in inquiry-based learning and social learning environments that promote discourse and groupwork.
Element 3: Reasoning	Children develop and apply reasoning to make, assess and justify ideas and conjectures. They engage in logical thought and actions such as analysing, proving, inferring and generalising. They plan and construct solid arguments to justify their explanations, proofs and decision making.
Element 4: Applying and problem-solving	Children investigate, develop, select, apply, interpret, model and compare a variety of problem-solving situations and strategies as they explore Mathematics and deepen their mathematical understanding. They apply their mathematical knowledge and skills in flexible, efficient and creative ways to solve problems; conduct investigations; and develop and share their computational thinking.

Connections across strands

The strand structure of the curriculum should not be taken to imply that topics are to be explored in isolation. Where appropriate, connections should be made between and across the strands, and with other areas of learning, to enhance their interrelatedness and relevance for learning. While there are numerous connections that can be made between strands, the following graphic (Figure 7) highlights a number of these connections.

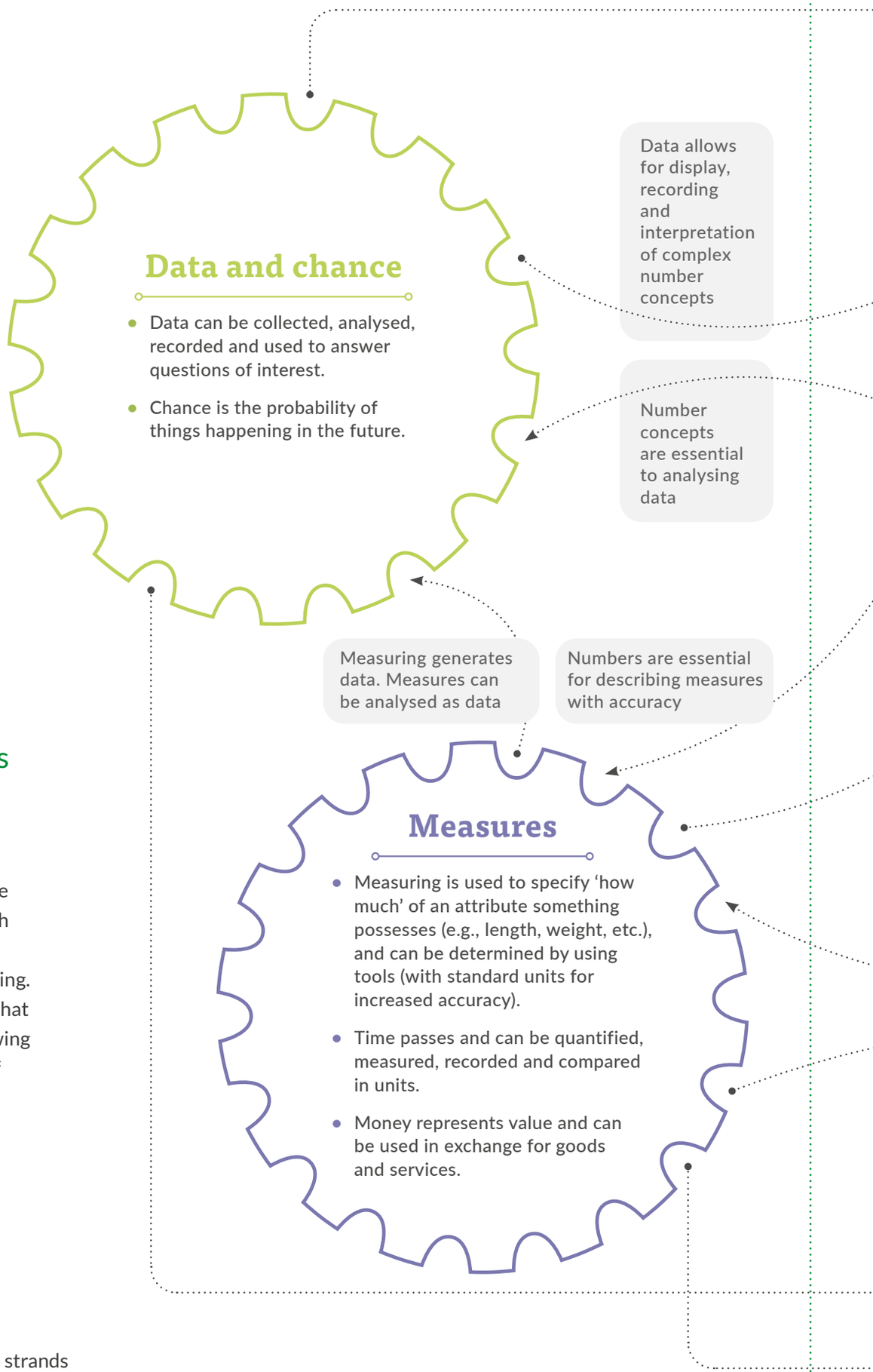


Figure 7: Examples of connections across strands

Data analysis can be used to organise information to uncover patterns and deduce relationships

Number

- Numbers can be used to quantify, label or tell the order of something.
- Counting allows us to quantify the amount of something in numbers.
- Ten is the base unit of our number system. It is the foundation for how we record, represent and calculate numbers.
- Number operations are used to calculate solutions accurately and efficiently.
- Fractions and decimals quantify parts of a whole.

Algebra represents numbers and relationships between different numbers

Algebra can be used to identify patterns, rules and relationships in number

Algebra

- Patterns and rules are key to establishing order and can be useful to make predictions and generalisations.
- Relationships can be conveyed as expressions and equations, which can then be used to find unknown information and solutions to problems.

Measures are a useful context for learning and understanding number

Numbers and number patterns can be represented geometrically

Shape and space have quantifiable attributes that can be described and measured using number

Algebra can be used to describe, map, identify and extend geometric patterns

Shape and space

- Objects, including our bodies, can be moved around for different purposes. Distance, direction and the location of objects in space can be analysed in mathematical terms using grids, maps and co-ordinates.
- Shapes can be composed and decomposed; and have attributes, which can be used for classification and analysis.
- Shapes can be transformed in a range of ways for a range of purposes.

The context of Shape and space is important for understanding and applying measures

Measuring quantifies some attributes of shape and space

Geometric representations can be useful in graphing and interpreting data

Equivalence can be determined and applied by understanding and examining relationships

5. Learning Outcomes

Learning Outcomes are used to describe the expected mathematical learning and development for all learners at the end of a two-year stage, when due account is taken of individual abilities and varying circumstances. Learning Outcomes articulate big mathematical ideas across different stages, and encompass the knowledge, skills and dispositions that children develop with the *Primary Mathematics Curriculum*. Some strand units have Learning Outcomes across all stages, some do not. These Learning Outcomes reflect the mathematical learning that is most appropriate for each stage.

Reflecting the principles and pedagogical approaches in the *Primary Curriculum Framework*, the 'stem' **'Through appropriately playful and engaging learning experiences'** is used to introduce Learning Outcomes across all stages. A playful and engaging approach to learning and teaching serves to present Mathematics as an open and accessible learning space, while also encouraging children to appreciate the beauty, challenge and power of Mathematics. This Learning Outcome stem emphasises a learning environment that motivates children to develop their mathematical proficiency and provides for rich learning experiences that reflect relevant pedagogical approaches as outlined in chapter 6, 'The *Primary Mathematics Curriculum* in Practice'.

The curriculum recognises that children learn and teachers teach in a variety of contexts. Therefore, the learning and teaching journey is varied and different across contexts. A Learning Outcomes approach recognises that teachers are best placed to determine the learning needs and strengths of the children in their class. They make decisions about what, and how, to teach and assess using appropriate pedagogical approaches and tools. Learning Outcomes, when shared with children, can support them to have clear expectations and to be active agents in their own learning.

A range of tools can be found in the Primary Mathematics Toolkit to support teachers in working towards Learning Outcomes across each stage.

	Learning Outcomes for Algebra Strand			
	Stage 1: Junior and senior infants	Stage 2: First and second classes	Stage 3: Third and fourth classes	Stage 4: Fifth and sixth classes
	Through appropriately playful and engaging learning experiences, children should be able to			
Patterns, rules and relationships	explore, extend and create patterns and sequences.	identify and express relationships in patterns, including growing or shrinking shape patterns and number sequences.	identify rules that describe the structure of a pattern and use these rules to make predictions. represent the relationships between quantities.	identify, explain and apply generalisations, including properties of operations, mathematical models and patterns. represent mathematical structures in multiple ways, including verbal expressions, diagrams and symbolic representations.
Expressions and equations		interpret the meaning of symbols or pictures in number sentences.	represent and express problems with known and unknown values in different ways to include the use of appropriate letter-symbols or words.	articulate, represent and solve mathematical situations through the use of expressions and equations that include letter-symbols.

Learning Outcomes for Data and Chance Strand				
	Stage 1: Junior and senior infants	Stage 2: First and second classes	Stage 3: Third and fourth classes	Stage 4: Fifth and sixth classes
	Through appropriately playful and engaging learning experiences, children should be able to			
Data	explore, interpret and explain data in a variety of ways for a range of purposes.	pose questions of interest, record and use data as evidence to answer those questions and communicate the findings.	pose questions of interest and collect, display and critically analyse data in a range of ways for a range of purposes and communicate the findings.	pose questions, collect, compare, summarise and represent data selectively to answer those questions. critically analyse and evaluate findings; and communicate inferences, conclusions and implications from the findings.
Chance			describe and test predictability and (un)certainty in events.	use probability to make informed decisions and predictions. represent and express probability in different forms.

	Learning Outcomes for Measures Strand			
	Stage 1: Junior and senior infants	Stage 2: First and second classes	Stage 3: Third and fourth classes	Stage 4: Fifth and sixth classes
	Through appropriately playful and engaging learning experiences, children should be able to			
Measuring	demonstrate an awareness that attributes such as length, weight, capacity and area can be measured and compared.	compare, approximate and measure length, weight, capacity and area using appropriate instruments and record using appropriate units of measurement.	compare, estimate and measure length, weight, capacity, area and volume using appropriate instruments and record and communicate appropriately. identify the relationship between equivalent units of measurement, and rename measures using equivalent units.	determine and calculate units of measurement in fractional and/or decimal form to solve practical problems. find, interpret and deduce measures experimentally with increasing precision.
Time	develop a sense of time and its uses.	understand how time is measured, expressed and represented. explore equivalent expressions of time.	compare, approximate and measure time using appropriate units of measurement. identify the relationship between different units and representations of time.	solve and pose practical tasks and problems involving the interpretation and calculation of time.
Money	develop an awareness of money and its uses.	recognise the value of money and use euro and cent in a range of meaningful contexts.	transfer knowledge of the base ten system in number to monetary contexts and use for purposes of calculation.	solve and pose practical tasks to investigate and make informed judgements about transactions and financial plans.

	Learning Outcomes for Number Strand			
	Stage 1: Junior and senior infants	Stage 2: First and second classes	Stage 3: Third and fourth classes	Stage 4: Fifth and sixth classes
	Through appropriately playful and engaging learning experiences, children should be able to			
Uses of number	develop an awareness that numbers have a variety of uses.			
Numeration and counting	develop an awareness that the purpose of counting is to quantify. use a range of counting strategies for a range of purposes.	demonstrate proficiency in using and applying different counting strategies.		
Place value and base ten	develop a sense of ten as the foundation for place value and counting.	understand that digits have different values depending on their place or position in a number. use estimation to quickly determine number values and number calculations.	explore equivalent numerical expressions of numbers using the base ten system.	investigate how decimals and percentages (and fractions) can be compared, ordered and expressed in related terms.
Sets and operations	recognise and understand what happens when quantities (sets) are partitioned and combined.	select, make use of and represent a range of addition and subtraction strategies.	understand and apply flexibly the four operations; and the relationships between operations.	build upon, select and make use of a range of operation strategies.
Fractions	develop an awareness of part-whole relationships using a variety of models (area, length and set).	recognise and name fractions according to their part-whole relationships. explore the concept of equivalence in terms of simple fractions.	compare and express in equivalent terms; and order fractions. calculate the fraction of quantities and express in multiple ways.	explore (model, compare and convert) the relationships between fractions, decimals and percentages. investigate proportionality and ratios of quantities (sets).

	Learning Outcomes for Shape and Space Strand			
	Stage 1: Junior and senior infants	Stage 2: First and second classes	Stage 3: Third and fourth classes	Stage 4: Fifth and sixth classes
	Through appropriately playful and engaging learning experiences, children should be able to			
Spatial awareness and location	develop a sense of spatial awareness in relation to their bodies and the immediate environment. describe the spatial features of objects and their relative position in space.	use spatial knowledge for the purposes of orientation and navigation. visualise and model location using symbolic co-ordinates.	describe, interpret and record directional instructions and location. compare and classify angles, recognising them as a property of a shape and as a description of a turn.	describe location on the full co-ordinate plane. interpret scale maps and create simple scale drawings.
Shape	explore and recognise properties of 3-D and 2-D shapes.	examine, categorise and model 3-D and 2-D shapes.	investigate and analyse the properties of 3-D and 2-D shapes and identify classes of shapes based on these properties. represent shapes with drawings and models, and calculate dimensions of shapes.	construct 3-D and 2-D models or structures given defined measurements and/or specific conditions. investigate and construct angles in the context of shape; and solve angle-related problems.
Transformation	explore the effects of shape movements.	understand that shapes and line segments can be reflected, rotated and translated.	model and explain the effects of transformations on shapes and line segments.	perform and devise a range of steps involving transformations. analyse and show how shapes are enlarged on scaled diagrams.

6. The *Primary Mathematics Curriculum* in Practice

As outlined in chapters 2 and 3, the rationale and aims of the *Primary Mathematics Curriculum* describe the vision held for children's mathematical learning in primary and special schools. This chapter describes the fundamental features of children's learning with the curriculum and the corresponding pedagogical practices that support and enhance learning.

6a. Learning primary mathematics

A mathematics-rich learning environment provides an important context for children's learning experiences with Mathematics. In providing for playful and engaging mathematical learning experiences, it is essential to offer opportunities for children to:

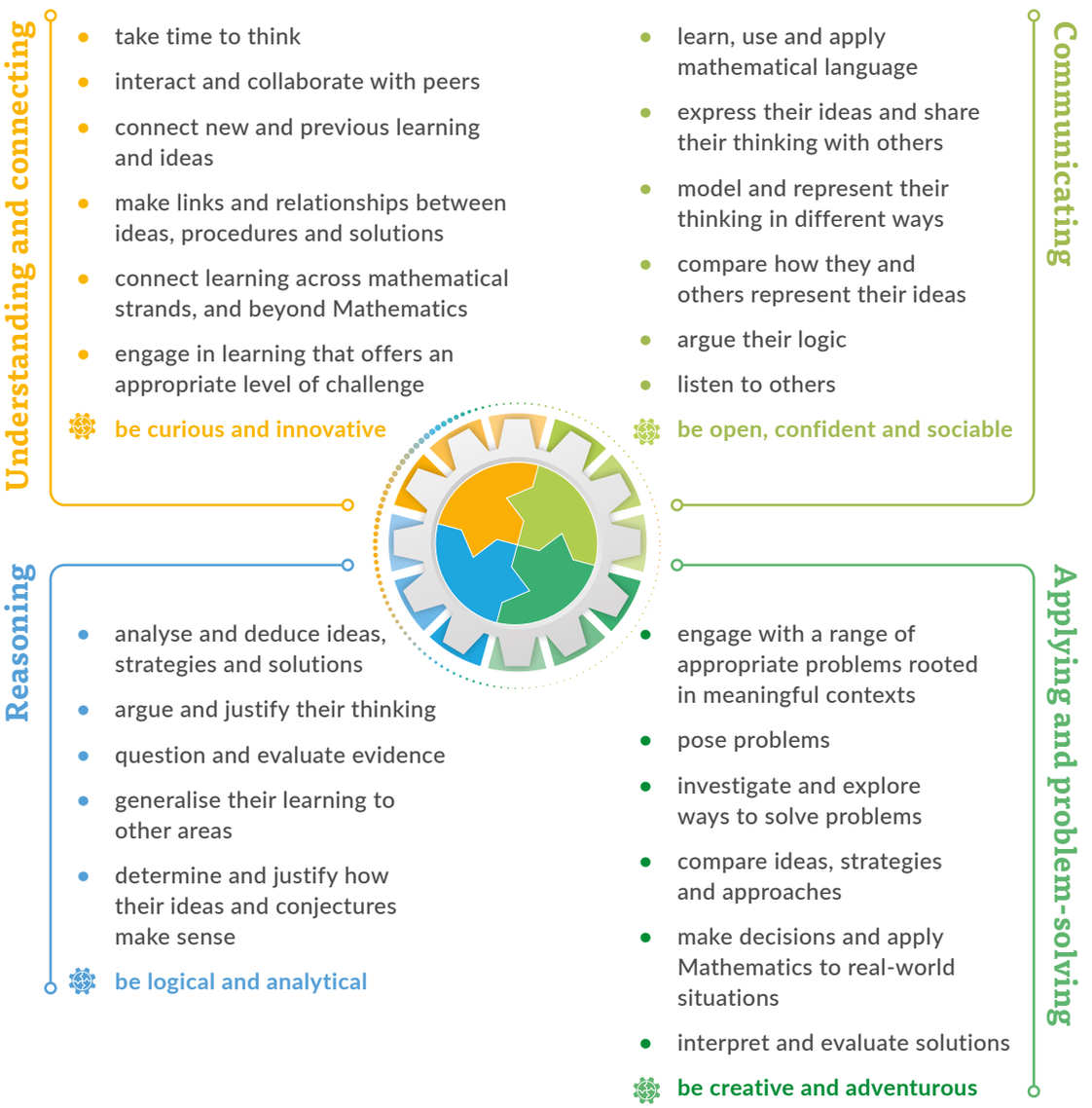


Figure 8: Mathematical learning opportunities

Technology and mathematical tools can be useful to support children's mathematical thinking and conceptual understanding. These can also reduce procedural load and support children to represent complex ideas.

6b. Teaching primary mathematics

'How' children learn is as important as 'what' children learn. The following five pedagogical practices are rooted in contemporary research. These practices are acknowledged as essential to the provision of quality mathematical learning experiences. They foster an inclusive learning environment and culture where children engage in rich and meaningful learning processes, as described in section 6a. Moreover, these pedagogical practices allow for children to learn and develop at a pace and level of challenge that is individual to their needs and interests whilst developing their confidence and proficiency in Mathematics. As such, these practices should permeate teachers' everyday decision-making about learning, teaching and assessment of Mathematics.

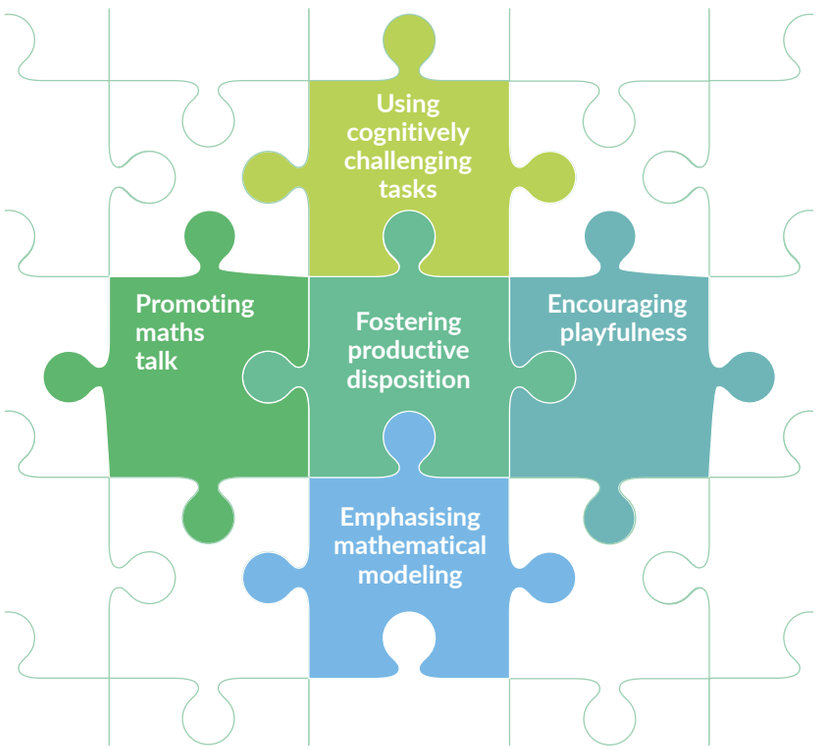
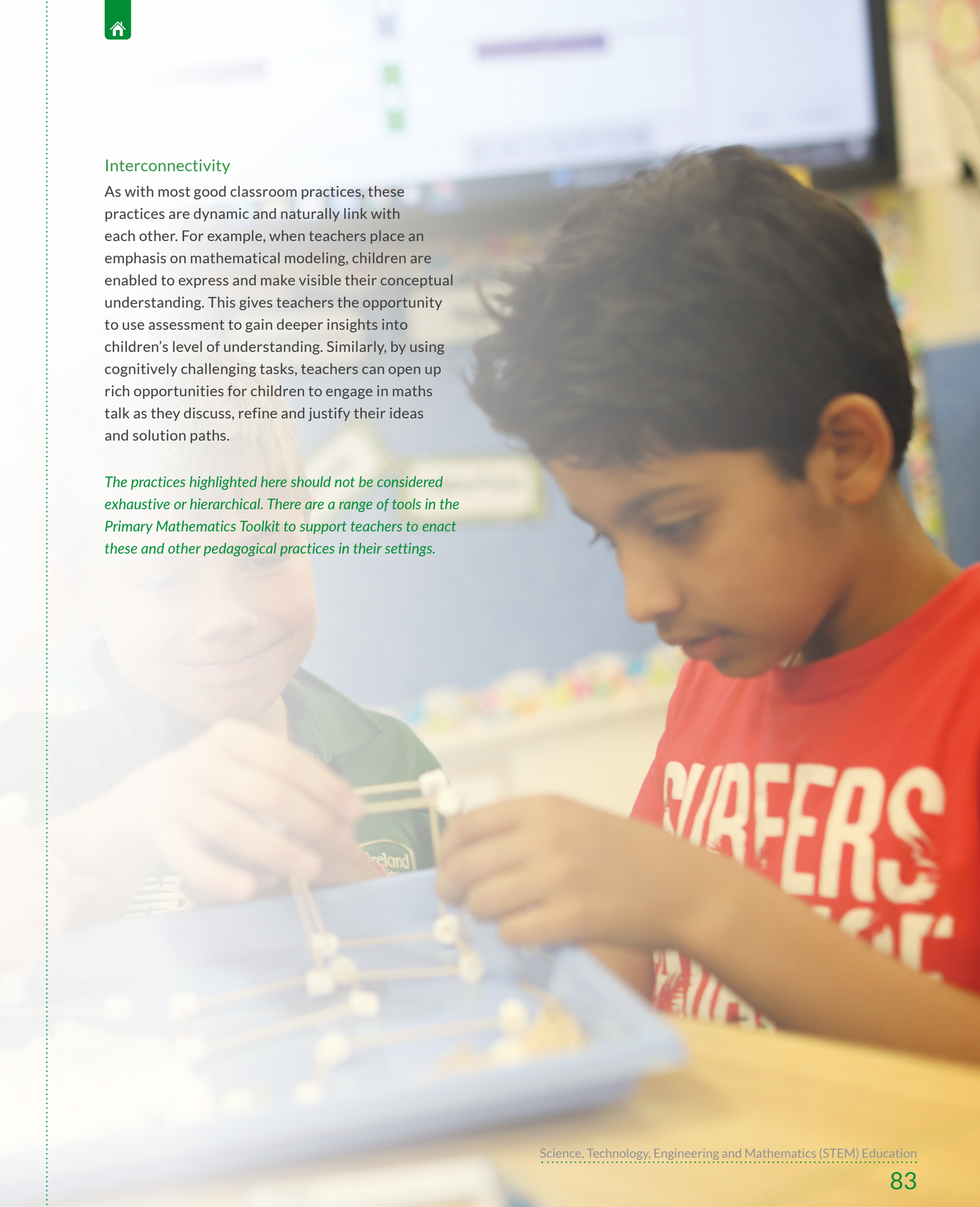


Figure 9: Five key pedagogical practices for the classroom

Interconnectivity

As with most good classroom practices, these practices are dynamic and naturally link with each other. For example, when teachers place an emphasis on mathematical modeling, children are enabled to express and make visible their conceptual understanding. This gives teachers the opportunity to use assessment to gain deeper insights into children's level of understanding. Similarly, by using cognitively challenging tasks, teachers can open up rich opportunities for children to engage in maths talk as they discuss, refine and justify their ideas and solution paths.

The practices highlighted here should not be considered exhaustive or hierarchical. There are a range of tools in the Primary Mathematics Toolkit to support teachers to enact these and other pedagogical practices in their settings.

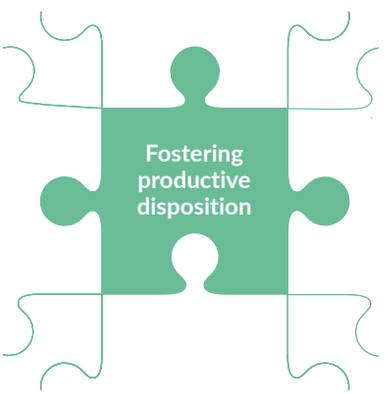


Fostering productive disposition

Dispositions are not static and can be nurtured or changed over time. The multiple ways in which children engage with Mathematics, how they perceive Mathematics, and the rich contexts in which Mathematics is meaningfully presented to them, are what help form and shape their dispositions towards Mathematics. In addition, attitudes to Mathematics and values, both at home and in the classroom, also have a strong impact on the development of the child's productive disposition for Mathematics. A classroom which emphasises the rich, useful and meaningful nature of Mathematics has a very positive effect on the child's disposition to learning.

Teachers can help foster children's productive disposition by:

- demonstrating enthusiasm for Mathematics themselves
- providing rich and meaningful contexts for learning
- celebrating effort and success
- valuing the process as well as the product of learning
- normalising struggle and mistakes as part of the learning process
- giving children opportunities to interact and work collaboratively with their peers
- facilitating children to find patterns and make connections
- encouraging children to take risks and persevere
- engaging children in meaningful self-assessment and reflection.



Fostering a productive disposition to Mathematics is a shared responsibility

Families, teachers and other significant adults in the child's life all play a role in presenting a positive view of Mathematics. When children see the application of Mathematics in situations they care about and which are relevant to their lives, it is more likely that they will engage with Mathematics in a meaningful way. Teachers can promote the development of productive disposition in the home by suggesting fun and meaningful mathematical activities and games that can be used with children.

Many everyday activities that children enjoy offer opportunities for a rich engagement with Mathematics. There are supports available in the Primary Mathematics Toolkit for families to promote positive and purposeful engagement with Mathematics in the home environment.

Encouraging playfulness with Mathematics

Playful learning is appropriate for all children across all stages of primary and special education. Children's learning experience in Mathematics, as in all other areas of learning, is characterised by play and playfulness. Throughout childhood, play is of value in and of itself and children have both a right and a desire to play. Before mathematical language and concepts are formally introduced to children, they typically engage in a range of mathematical processes. These include testing, discovering, revising, extending, combining and transforming.

Play is an opportunity for teachers to engage with children in purposeful and sensitive ways. By infusing playfulness in children's learning experiences and the interactions between the teacher and child, children are encouraged to develop a productive disposition towards Mathematics, and to remain interested and engaged in the process of learning.

Mathematical learning can be greatly enhanced in a play environment that is interactive, engaging, inclusive and supportive; and that provides opportunities for exploration, investigation, challenge, creativity, choice and independence. Play provides a context for mathematical thinking and the development of mathematical language and concepts, with clear potential for promoting maths talk. Through play, children can be supported to engage in increasingly sophisticated and cognitively challenging activities and make choices about their learning. In doing so, their mathematical concepts are strengthened and extended; the tools, approaches and strategies they employ are refined; and the opportunities for children to make connections and share ideas are increased.

Teachers can help encourage playfulness with Mathematics by:

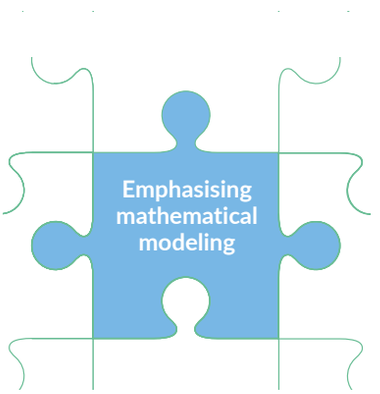
- being playful in their own dispositions and interactions with children
- tapping into children's interests and curiosities
- integrating mathematical learning with playful activities throughout the day
- signalling when children encounter Mathematics in spontaneous play and exploration
- introducing and reinforcing mathematical language as it arises through play
- encouraging multiple means of expression and representation
- providing opportunities for children to explore and experiment with mathematical ideas
- allowing a safe space for spontaneity, creativity and imaginative play with Mathematics
- providing access to a wide range of resources, visual supports and technologies.

Emphasising mathematical modeling

Mathematical modeling involves children using Mathematics to describe a problem-context and determine meaningful solutions to the problem. Children form models through a process of testing, revising and expressing their interpretation of different mathematical ideas, experiences, problems and situations, typically posed to them as questions or challenges. Children naturally generate their own informal mathematical models in a way that is context-specific and makes sense to them. As children's knowledge, understanding and experience grows, they may develop more formal, sophisticated and efficient models which they can use to share, connect and communicate their ideas with others. They may also transfer these models to a range of different contexts in a way that is meaningful to themselves and others. In forming models, children might use physical actions, spoken words, objects, images (e.g., graphs, diagrams and pictures), symbols or written words. While accuracy is valued, mathematical modeling places more importance on exploration, sense-making, conceptual understanding and flexibility in thinking.

Teachers can help emphasise mathematical modeling by:

- providing opportunities for sense-making
- allowing freedom and autonomy for children to develop and express their own models and solution pathways
- using model-eliciting activities, questions, prompts and feedback to provoke situations for modeling
- encouraging individuality, choice and independence
- facilitating children to build, test and apply mathematical models
- challenging children to test and refine their models through collaboration
- celebrating diversity and creativity in working with mathematical models
- supporting children to generalise their models for a range of different contexts and purposes.



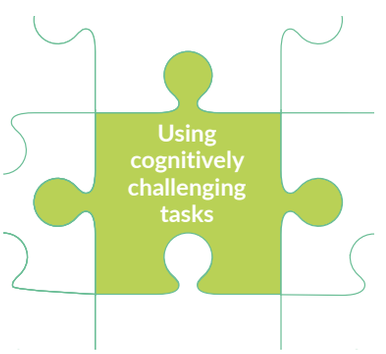
Using cognitively challenging tasks

Cognitively challenging tasks are rich, higher-order learning opportunities that should appropriately stretch and challenge children's conceptual understanding as they encounter significant mathematical ideas and situations. Sometimes referred to as low-threshold high-ceiling tasks, these tasks should provide all children with the opportunity to access Mathematics, while offering the potential for deeper engagement. Simple, considered and well-pitched tasks can present a rich medium through which children can engage meaningfully in mathematical content and processes. They also offer opportunities for teachers to incorporate other key pedagogical practices, such as maths talk and mathematical modeling.

When used effectively, children perceive and experience these tasks as having few prescribed or memorised rules or methods; as well as an opportunity to freely explore different ways of solving problems. It is through exploring these tasks and grappling with problems and solutions in meaningful ways that children deepen their understanding of Mathematics. Through their efforts to engage with cognitively challenging tasks, children develop persistence and resilience which are essential to a productive disposition for Mathematics.

Teachers can help promote the use of cognitively challenging tasks by:

- selecting, designing or modifying tasks to appropriately stretch and deepen children's understanding
- providing opportunities for deep and sustained engagement with mathematical content and processes through the use of tasks
- allowing children to grapple with ideas and problems freely and to explore problems with multiple correct solution pathways
- encouraging different ways of solving problems
- assisting children to make connections with prior and new learning
- encouraging children to express and communicate their ideas frequently and openly
- holding high expectations for what children are capable of understanding, doing and communicating
- providing opportunities for children to collectively share and evaluate their experiences from working with tasks
- celebrating individual and collaborative effort and success in grappling with challenging tasks.



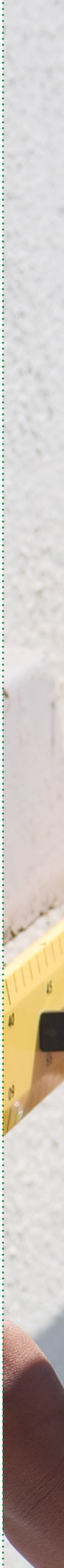
Promoting maths talk

Maths talk is a collaborative process where children's thinking, strategies and ideas are expressed, shared and/or exchanged. This allows children to reflect on their own understanding; define, present and justify their ideas; make sense of and critique their own ideas and those of others; and develop their ability to express and articulate their thinking. Through maths talk, children can engage in rich mathematical processes which deepen their understanding of Mathematics. For example, by presenting, arguing or justifying their mathematical ideas, they can refine, consolidate or extend their existing knowledge.

Maths talk equips children with tools to make their thinking visible. These tools include words, sign language, body language and gestures, symbols, diagrams, concrete manipulatives and technology. All children are mathematical language learners, regardless of their language proficiency, and all can engage in maths talk. Opportunities should be provided for children to communicate in ways that are meaningful for them. The learning environment should be flexible in terms of recognising and catering for multiple forms of expression and multiple means of engagement. The physical space should provide children with access to a variety of materials that stimulate and enable maths talk.

Teachers can help promote the use of maths talk by:

- providing a safe environment for children to share and exchange thinking and ideas
- encouraging active listening, respect and value for all contributions
- identifying and selecting appropriate situations and problems to promote maths talk
- re-casting everyday experiences using mathematical words and phrases
- prompting maths talk through strategic, skilful, open and thoughtful questioning
- providing suggestions for parents on how to promote and stimulate maths talk at home
- allowing waiting time and time for sustained interactions, collective sharing and reflection
- re-voicing children's mathematical ideas.



6c. Assessing primary mathematics

Assessment is an integral part of learning and teaching. It involves teachers and children working together to use information to inform and support learning and teaching. Teachers are committed, skilled and agentic professionals who make key decisions every day about mathematical learning and teaching. These decisions are informed and shaped by:

- knowledge of the child and their prior learning
- knowledge of the curriculum
- knowledge of pedagogy.

The child and their prior learning

Children engage with and process their learning in Mathematics in different ways depending on their age, ability, strengths, preferences and interests. Given the incremental nature of mathematical learning, having a solid knowledge of children's prior learning and understanding is fundamental. This knowledge informs the appropriate learning sequence and scaffolds that support children to build on and deepen their knowledge, concepts and skills. Prior learning can be assessed through any activity that offers children opportunities to express their understanding and reasoning. The more that is understood about where children are at in their learning journey and how they learn, the better their mathematical understanding and productive disposition can be nurtured, and the learning environment tailored to meet their needs.

The curriculum

As children work towards Learning Outcomes, and develop and deepen their mathematical proficiency, assessment provides useful insights and information about children's progress. This information can be observed, interpreted, and used by teachers or children in a responsive way to support ongoing decision-making about the next steps for the child's mathematical learning journey.

Pedagogy

By reflecting on the learning opportunities provided to children (as described in section 6a) and mathematics-related pedagogies enacted in the classroom (as described in section 6b), teachers can refine and adjust both the learning experiences and the learning environment. This serves to ensure that teachers are responding appropriately to children's learning. Professional conversations with colleagues, continuing professional development and accessing mathematical teaching resources and tools provide further supports for teachers.

Children as mathematical learners: Providing children with regular time to talk about their learning, reflect and determine their next steps contributes to their identity and confidence as mathematical learners. In addition to informing learning and teaching, when used effectively, assessment can also help children to become increasingly independent and motivated in learning Mathematics.

By equipping children with appropriate skills, and by sharing the focus of learning and agreeing criteria for successful learning with them, teachers can give children the tools they need to peer and self-assess, reflect on and take greater responsibility for their own mathematical learning.

Opportunities for assessing mathematical learning: The ability to recognise Mathematics in children's everyday activities and to extend the potential learning arising from these everyday activities is critical to planning for assessment in the classroom. Children's mathematical learning can be assessed along a continuum from 'intuitive' to 'planned interactions' to 'assessment events' as shown in Figure 10. The three types of assessment are complementary, and necessary, to gain a comprehensive picture of a child's progress and achievement.

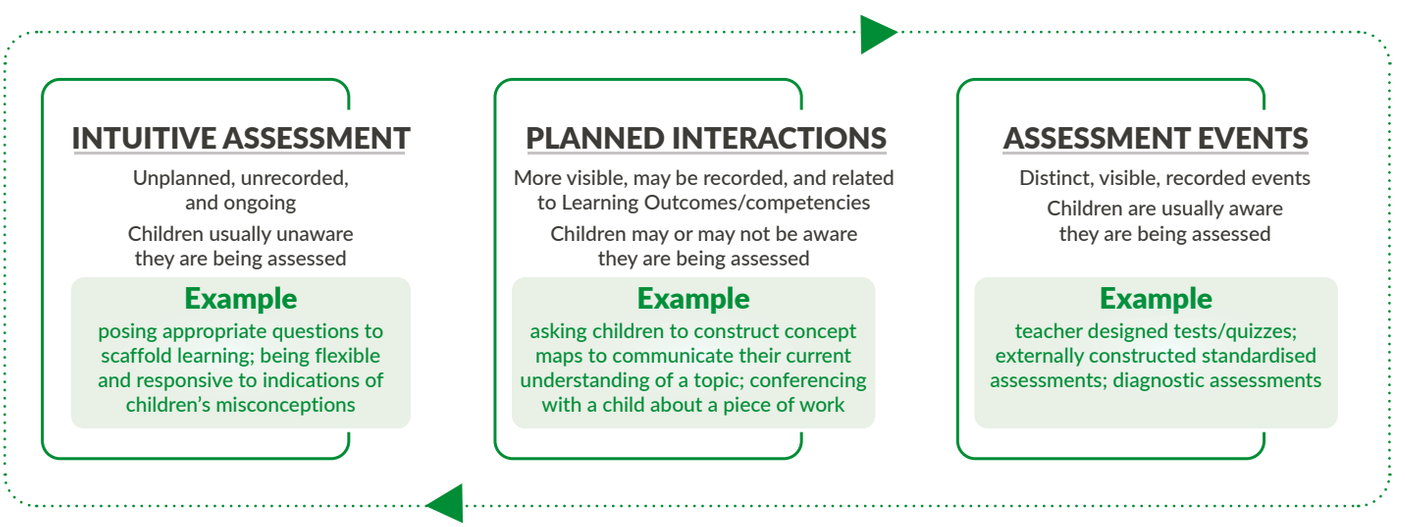
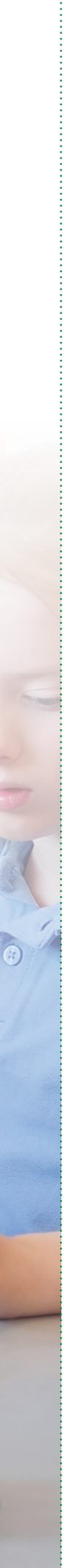


Figure 10: Assessment continuum

During the mathematical learning process, assessment is likely to occur incidentally, intuitively and in response to contingency moments i.e. unplanned and unexpected responses from the child. Providing an openness for such contingency moments, and capitalising where appropriate on insights gleaned from children's responses, questions, problems and tasks, can allow for very rich assessment data.

The Primary Mathematics Toolkit contains supports which may be useful for teachers in assessing children's mathematical learning.



Methods for assessing mathematical learning

As teachers continually assess children's mathematical knowledge, skills and dispositions, they are likely to use multiple assessment methods, in inter-changeable ways, to build a rich picture of children's mathematical learning. Below are some of the methods likely to be used.

Observations: Teachers are well placed to actively monitor and observe children as they engage in mathematical learning experiences and to respond to opportune learning situations as they arise organically.

Questioning: Effective, well-crafted and probing questions that are open, related to the focus of learning and accompanied by appropriate wait time encourage children to think deeply, develop their understanding and express their ideas and solutions.

Conferencing: Through teacher/child, peer/peer and group meetings, teachers can gain an insight into children's mathematical thinking, the nuances of their learning and their experience of learning.

Tasks: Tasks can be very useful to provide an insight into children's level of understanding and their preferred methods for learning Mathematics. Assessment tasks can be written, oral or practical.

Feedback: The provision of feedback, focused on the mathematical learning or task in hand, can help children identify and celebrate their progress and achievements, pinpoint challenges they experience, give direction for future work and decide what the appropriate next steps might be.

Portfolios: Portfolios can be assembled, digitally or otherwise, to compile evidence of children's mathematical learning and provide a source of self-reflection, feedback and assessment. Artefacts could include pictures, recordings and work samples, among others.

Summative tests: When used in conjunction with other forms of assessment, analyses from summative tests can provide an important source of detailed feedback on children's learning.

Peer and self-assessment methods: Teachers may also use strategies to support children to engage in peer and self-assessment and rely to a lesser degree on extrinsic affirmation and motivation. An open, respectful and collaborative classroom culture and learning environment is essential to support children to think about their own learning and that of others. Children working in pairs or small groups facilitates group reflection and feedback sharing. It may be useful to display children's work to allow for peer and self-assessment.

Peer and self-assessment can also be promoted by:

- allowing time and space for children to reflect on and discuss their mathematical learning
- making explicit to children what they are going to learn, how they might build on prior knowledge and possible connections with other areas of Mathematics familiar to them
- suggesting criteria for children to use in monitoring their progress
- promoting and celebrating respectful and open collaboration, reflection and sharing.

7. Outline of the Primary Mathematics Toolkit

The Primary Mathematics Toolkit provides practical support for teachers in building rich mathematical learning experiences for children.

The components of the toolkit are mathematical concepts, progression continua, support materials and examples of children's learning.

Mathematical concepts

Mathematical concepts are considered key ideas that underpin each Learning Outcome. These key ideas may provide useful entry and reference points in relation to planning, teaching and assessment and may serve to remind teachers of key mathematical knowledge at each stage. The mathematical concepts are situated in the Primary Mathematics Toolkit. They are presented according to stages 1 to 4 and link with the corresponding Learning Outcomes. Children will develop their understanding of these corresponding mathematical concepts through engaging with the mathematical processes, as outlined in the elements.

Progression continua

In working towards Learning Outcomes, teachers seek to engage children in a range of appropriately playful and engaging learning experiences. These learning experiences should be responsive to the needs, interests and abilities of every child. The progression continua outline a sample learning trajectory of Mathematics at primary level. They suggest a series of learning experiences, which children might engage with as they develop and deepen their mathematical knowledge, skills and dispositions.

Classrooms are complex and children come to school with different experiences and learn in diverse ways. They also learn and develop at different rates. Therefore, while the progression continua suggest a sample learning journey in Mathematics at primary level, they are not intended to be prescriptive or exhaustive. Indeed, children rarely learn in a linear or typical way. Some children may move forwards and backwards across the continua for different strands or elements of mathematical learning. Others may work within one progression step or across a small number of steps for the duration of their primary years. Teachers should exercise professional judgement when making decisions as to the learning experiences which are most appropriate for the children in their classroom.

There are fifteen progression continua tables, one for each of the strand units. Each continuum describes the learning journey across eleven progression milestones (a-k) in terms of mathematical content and processes.

Support materials

The Primary Mathematics Toolkit includes a range of support materials for teachers to use with the *Primary Mathematics Curriculum*. The support materials include important resources and reference material to support teachers to enact the curriculum in a meaningful way. Support materials include descriptions and examples of the pedagogical practices outlined in chapter 6, supports for fostering a rich learning environment, as well as supports for promoting links with home and community. These materials are developed and reviewed in response to research and the evolving needs of children, teachers and school communities.

Examples of children's mathematical learning

The Primary Mathematics Toolkit includes a range of examples of children's mathematical learning and development. These examples illustrate teacher-child interactions, cognitively challenging tasks, learning in integrated contexts and problem-based learning. In doing so, it is intended that these examples will exemplify playful and engaging learning experiences and demonstrate good pedagogical practices as children work towards Learning Outcomes.

8. Glossary

The glossary highlights key words and terminology used in the curriculum which may be new to teachers or which may require further explanation.

Argumentation	A dynamic process for discovering and understanding new mathematical ideas and presenting the rationale for same.
Child agency	Children are active in their own learning and can display their agency by taking the initiative in learning situations, by observing and becoming involved in ongoing events, or by initiating conversations with others.
Collaborative learning	Learning that takes place in social contexts and uses the resources of the environment.
Conceptual understanding	Understanding of mathematical concepts, operations and relations.
Conferencing	Dedicated time, space or meeting to elicit and gain a deeper insight into children's level of understanding.
Conjecture	An educated guess that is based on known and/or incomplete information.
Contingency moments	Unplanned or unexpected events or responses from children that occur during the learning process.
Co-ordinate plane	A two-dimensional plane divided into four quadrants.
Data	A collection of information or facts, such as numbers, words, measurements, observations or other descriptions.
Disposition	An enduring habit of mind and action. The tendency to respond to situations in characteristic ways.
Generalising	To make assertions, claims or justifications as to how children's understanding is applicable or transferrable to other circumstances.
Learning environment	Describes any space in which children learn or develop their understanding.
Low-threshold high-ceiling tasks	Tasks that provide accessible entry points for learning with the scope for exploration and challenge for all learners.

Mathematical modeling	Involves using Mathematics to conceptualise a problem or situation and determine meaningful solutions, and in doing so help children formalise their mathematical learning in a way that makes sense to them.
Mathematical proficiency	Consists of the five intertwined and interrelated strands of conceptual understanding, procedural fluency, adaptive reasoning, strategic competence and productive disposition.
Maths talk	A collaborative process where children's thinking, strategies and ideas are discussed, shared and exchanged
Peer assessment	Involves children looking at each other's work in a reflective way.
Productive disposition	The inclination to see Mathematics as something worthwhile, useful and doable.
Re-voicing	The teacher repeats some or all of what the child has said and then asks the child to clarify whether or not this may be correct.
Rotation	Turning around a centre point.
Scaffolding	Describes the process by which teachers support and guide children's learning, by building on their current knowledge and experience.
Self-assessment	Involves children looking at their own work in a reflective way.
Summative assessment	Assessment is summative when it is used to evaluate children's learning at the end of the instructional process or of a period of learning.
Symbolic co-ordinates	Used to describe the position or location of a point or object.
Translation	A shape or line is translated when it is moved a certain distance from its original position (without turning).

References

Delaney, S. (2020). *Number in the Senior Primary Classes: Commissioned Research Paper for National Council for Curriculum and Assessment*. Accessed at: **https://ncca.ie/media/4622/primary_maths_research_number_seniorclasses.pdf**

Dooley, T. (2019). *Learning and Teaching Primary Mathematics: An Addendum to NCCA Research Reports 17 and 18*. Accessed at: **https://ncca.ie/media/4087/primary_maths_research_addendum_2019.pdf**

Dooley, T., Dunphy, E., & Shiel, G. (2014). *Mathematics in Early Childhood and Primary Education. Research Report 18*. Dublin: National Council for Curriculum and Assessment.
Accessed at: **https://ncca.ie/media/2147/ncca_research_report_18.pdf**

Dunphy, E. Dooley, T. & Shiel, G. (2014). *Mathematics in Early Childhood and Primary Education. Research Report 17*. Dublin: National Council for Curriculum and Assessment. Accessed at: **https://ncca.ie/media/1494/maths_in_ecp_education_theories_progression_researchreport_17.pdf**

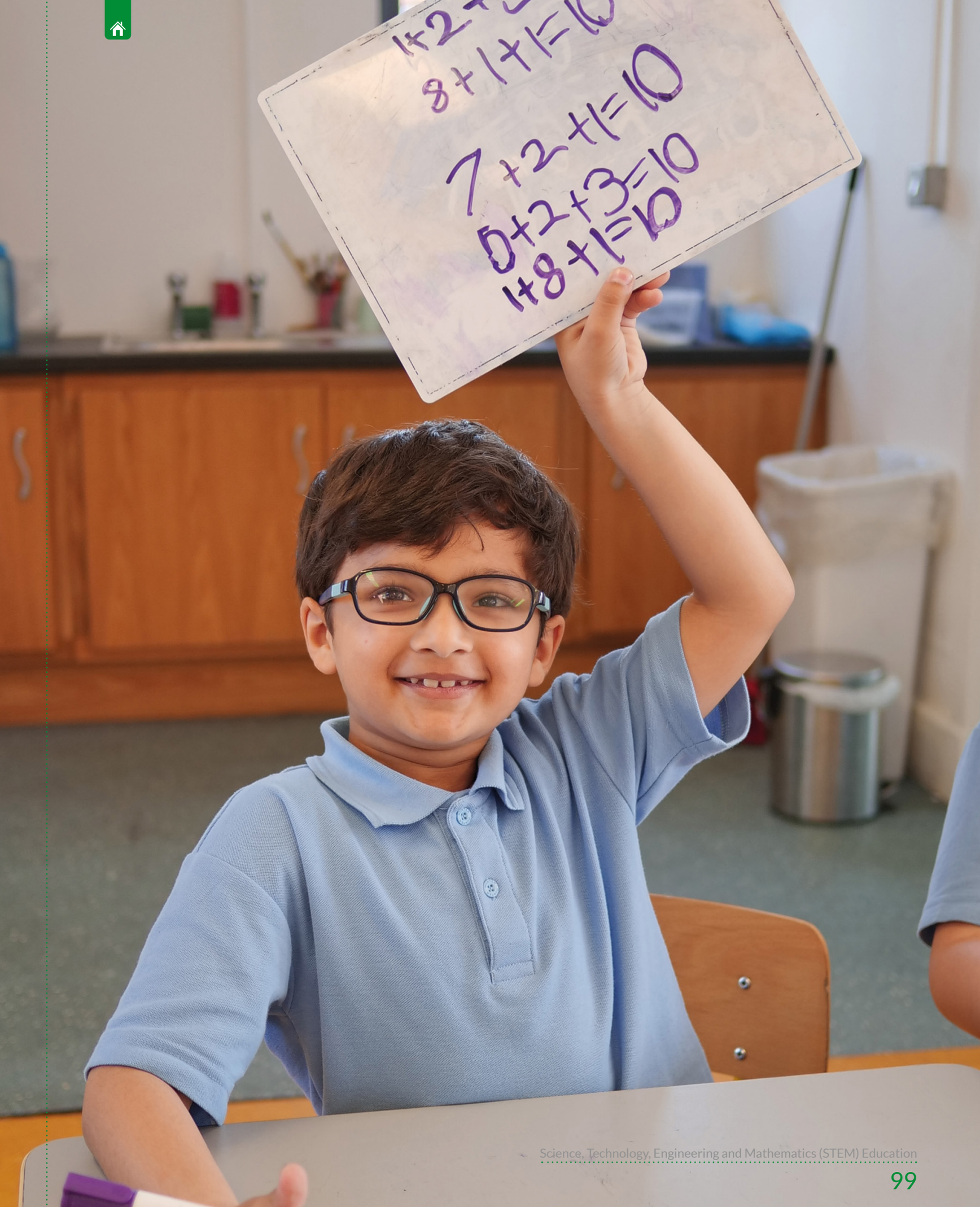
Leavy, A. (2020). *Data and Chance in the Senior Primary Classes: Commissioned Research Paper for National Council for Curriculum and Assessment*. Accessed at: **https://ncca.ie/media/4620/primary_maths_research_data_and_chance_seniorclasses.pdf**

National Council for Curriculum and Assessment (2016). *Background Paper and Brief for the development of a new Primary Mathematics Curriculum*. Dublin: National Council for Curriculum and Assessment.
Accessed at: **https://ncca.ie/media/1341/maths_background_paper_131016_tc.pdf**

Nic Mhuirí, S. (2020a). *Measures in the senior primary classes: Commissioned research paper for National Council for Curriculum and Assessment*. Accessed at: **https://ncca.ie/media/4626/primary_maths_research_measures_seniorclasses.pdf**

Nic Mhuirí, S. (2020b). *Shape and Space in the Senior Primary Classes: Commissioned Research Paper for National Council for Curriculum and Assessment*. Accessed at: **https://ncca.ie/media/4624/primary_maths_research_shape_and_space_seniorclasses.pdf**

Twohill, A. (2020). *Algebra in the Senior Primary Classes: Commissioned Research Paper for National Council for Curriculum and Assessment*. Accessed at: **https://ncca.ie/media/4619/primary_maths_research_algebra_seniorclasses.pdf**


8+1+1=10
7+2+1=10
0+2+3=10
1+8+1=10

An Roinn Oideachais agus Óige
Department of Education and Youth