



مجلس أبوظبي للتعليم
Abu Dhabi Education Council
Education First



A GUIDE TO DEVELOPMENT AND PROMOTION
OF INNOVATION SKILLS

Iqraa

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Introduction and Context

ADEC's mission 'To produce world-class learners who embody a strong sense of culture and heritage and are prepared to meet global challenges' is in line with the national agenda as set out by the Abu Dhabi vision 2030:

'We must not rely on oil alone as the main source of our national income.
We have to diversify the sources of our revenue and construct economic projects that will ensure a free, stable and dignified life for the people.'

Education has been changing throughout the ages. Before the foundation of formal systems, education of young people was based on transmission of knowledge and skills from person to person within families and communities. A common thread throughout the history of education, and especially since the establishment of formal universal schooling, has been equipping learners with the knowledge and skills needed for living and working. Past generations have had the advantage of reasonable certainty about the skills and knowledge that students would need as adults; there is no such certainty today. The availability of knowledge through digital networks has meant that the focus of education is not on acquiring knowledge; up-to-day knowledge is readily accessible through global networks. The focus has shifted to developing the skills to access knowledge, having the capacity to assess the quality of the knowledge and the knowledge sources and create new knowledge. Education systems are responding to this new reality by embedding specific, higher-order skills in their curriculums with the intention of enabling students to become flexible and adaptable citizens for the rapidly changing societies and economies of the future.

Despite the uncertainty about the skills today's students will need for their social and economic roles as adults, agreement is beginning to emerge among educators that the best preparation is to equip students to be innovative, flexible and adaptable to the realities that they will face in their roles as learners and in their social and economic roles as adults. Therefore, schools need to adapt their curriculum and teaching approaches to foster the personal qualities of persistence and resilience, encourage risk taking and collaboration and build on the natural curiosity and creativity of children. School leavers would benefit from increased capacity for critical thinking and problem solving and would be better equipped for independent learning and to be entrepreneurial, creative adults. One of the central aims of a modern education systems is to develop confident adults who are able to display initiative in a rapidly changing world.

OECD (2009) defines innovation as '**investment to produce and apply new knowledge**'. Innovation is the creative process by which a new concept or product is conceived or invented and made available for use through commercialization. Through innovation, each of us explores and discovers our unique abilities to create new solutions in areas such as mathematics, science, technology, engineering and the arts.

Innovation is founded in research and development, which involves pushing the boundaries of our knowledge and achieving advancements that benefit our society, our nation and beyond.

Therefore, ADEC has launched the *Innovation Initiative* to embed the development of these essential skills in the everyday school life.

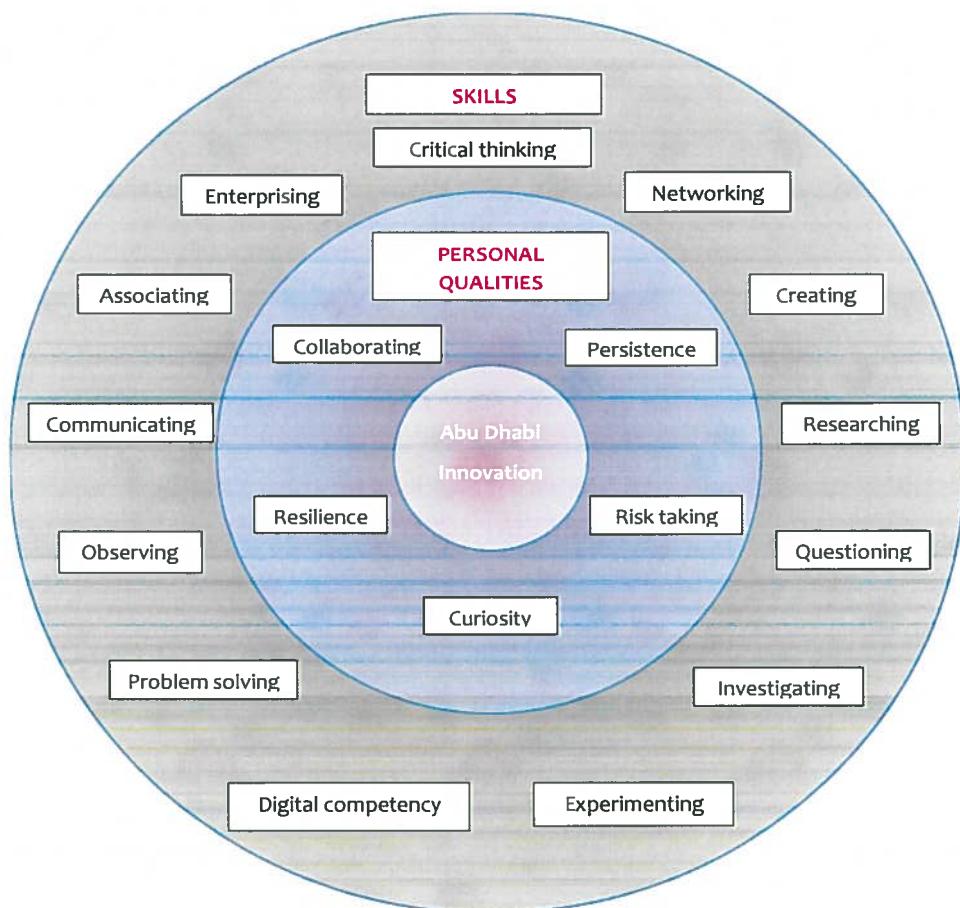
The United Arab Emirates School Inspection Framework (2015) defines innovation as 'the generation of new and creative ideas and the use of new or improved approaches.' The wide range of innovation initiatives launched by the Abu Dhabi Education Council in 2015 aims to increase awareness among school leaders, teachers and the education community more widely of the need to embed a culture of innovation in schools and to incorporate the development of education skills throughout the school curriculum. This purpose of this guide is to offer a range of ideas and suggestions that schools can adapt and use to suit their circumstances.

Aims of ADEC's Innovation Standard Initiative

The innovation standards initiative intends to increase awareness among the education community of the personal qualities, values, attitudes and competences students need to learn so that their innovation skills will developed as part of their portfolio of academic and social skills. The specific objectives of the initiative are to:

- provide guidance to schools on developing the personal qualities and identifying the pedagogies and opportunities in curriculum that support innovation
- incorporate performance indicators for innovation in the Inspection Framework, the school self-evaluation form (SEF) and empower schools to support their development through their school improvement plan (SIP)
- inclusion of the measure of 'Innovation' when measuring learning skills & education quality

Skills and Personal Qualities that Support Innovation



Not everything students learn at school is taught. Some of what they know, believe and feel is acquired through social experience or is influenced by social values and beliefs. To teach, learn, practise or master a set of skills or dispositions, teachers need to be clear about what they are trying to achieve. They need to be able to describe a series of incremental learning steps and associated activities to develop and practise the skills that underlie innovation competences. Therefore, the teaching of innovation skills has to be consciously embedded in each school's curriculum and be included in the learning outcomes planned for lessons.

In the mathematics curriculum for grade 1, for example, there are numerous discrete skills that are part of the mathematics programme: children are taught to order numbers, letters, days of the week; compare things and order them by size or weight or colour or shape; they learn to add things together; to read measurements from rulers, thermometers, weighing scales, to record information in various ways. The list of skills and concepts that children learn is in excess of 100 at every grade level. All of these skills and concepts form the knowledge base on which future learning in mathematics will be built. However, planning the achievement of learning outcomes in innovation will impact on how the mathematical skills are taught, the questions that students are asked, the learning tasks that are set and the degree to which the learning is student led or teacher led.

Innovation Skills Standards

Measuring innovation

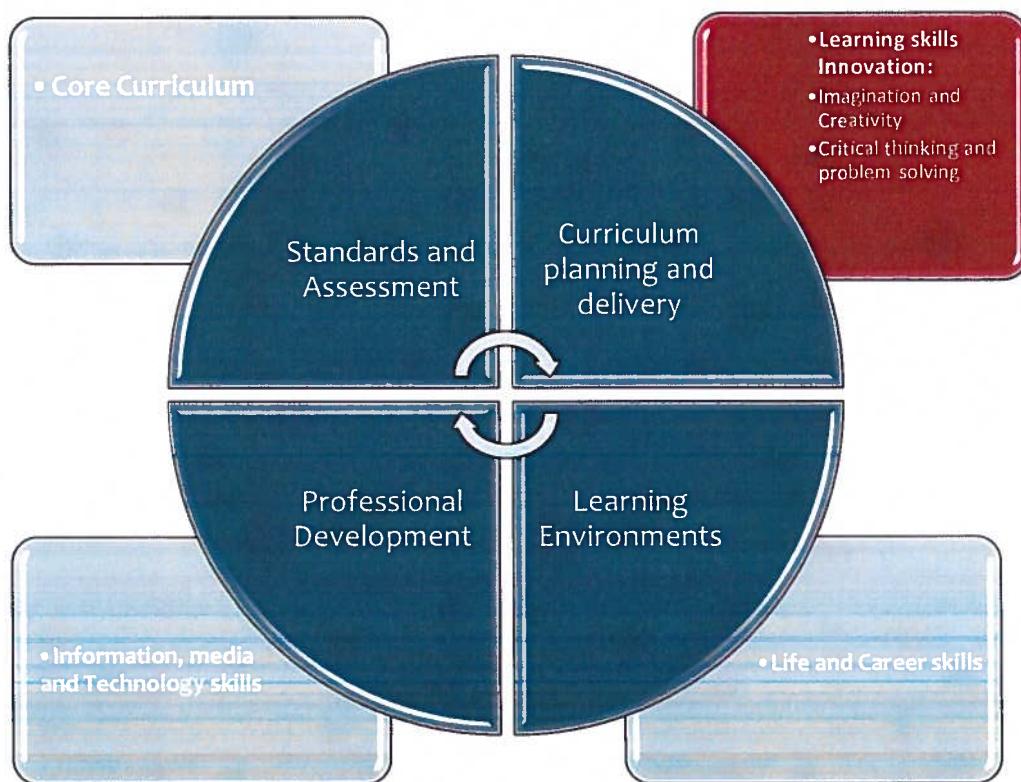
Innovation Skills Standards

The UAE Inspection Framework identifies the following elements of students' performance, when measuring Learning skills:

- Students' engagement in and responsibility for their own learning
- Students' interactions, collaboration and communication skills
- Application of learning to the real world and making connections between areas of learning
- Innovation, enterprise, enquiry, research, critical thinking, problem solving and use of learning technologies.

All students must learn the essential Innovative learning skills, such as:

- Imagination and creativity
- critical thinking and problem solving



Adapted from 'Framework for 21st Century Learning' (www.P21.org)

Students must develop innovation skills regardless of the core curriculum they are being taught, in order to be prepared for the next stage of their education and the world of work, and as concerned and responsible UAE citizens. The Innovation Skills Standards aim to describe the process and learning behaviours that students develop as they make progress in their learning. These standards by no means **intend to evaluate the competences and skills that students develop, in isolation**, as innovative learning skills are taught and developed within the context of core knowledge instruction, embedded across the curriculum, as explained by the figure above. Importantly, Innovation Skills Standards are not intended to measure the outcome(s)/ product of the learning, but the **process and the skills students develop and use in their learning**.

It is important that the successful development of these innovation skills will result from embedding them in the planning and delivery of a school's chosen curriculum, fully integrated into all school and classroom activities. Innovation skills can be taught by helping students to:

- **First** understand the skills and how to use them. Students at this stage require a clear structure and steer to acquire these skills and gain confidence in their use.
- **Then**, practise the use of skills. Students demonstrate growing independence and less structure is required in the activities.
- **Eventually**, students gain confidence in their capacity and ability to use these skills to learn and create.

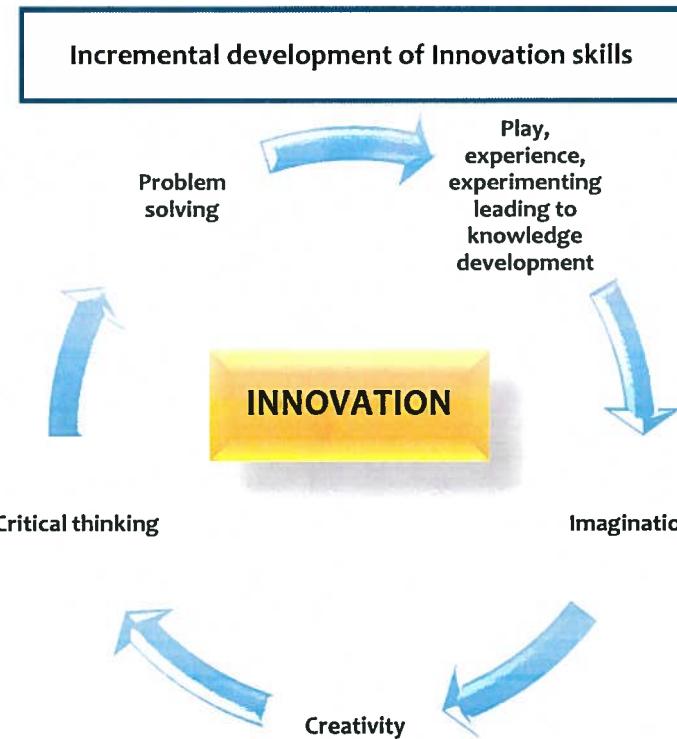
Progress may be seen in the refinement of students' skills or in their application to tasks that move from concrete to abstract, simple to complex, personal to general, familiar to unfamiliar. Learners also progress from needing support or scaffolding to independent working. There may also be progression from group working as a directive to a managed learning strategy where individual, paired and collaborative work is initiated by the student better to meet the needs of the task.

The Innovation Skills are further broken down into components. (See table below).

Innovation skills	Description
Imagination and Creativity	Creative skills go beyond the ability of making something new or original. It is the ability to imagine, generate many ideas, variables, approaches, questions and solutions, e.g. brainstorming, divergent thinking or planning, as well as the ability to use and adapt objects, ideas and material in a range of ways and for a variety of purposes. In language classes or creative writing students can be enabled to see and develop connections, similes or metaphors. Creativity includes building on ideas/ starting points to refine or combine them to be finished and complete, more complex or organic. It may also require students to use skills, effects, styles techniques, methods to make new from old.
Critical thinking and problem solving	Critical thinking and problem solving are closely related. Both require the skills and capacity to examine something in detail. They also involve examining and breaking information into parts, by identifying motives or causes; making inferences and finding evidence to support generalisations. Problem solving is an active learning process using acquired skills or knowledge learned to problem-solve; address challenges and/or devise viable solutions to questions or problems. Critical thinking and problem solving usually mean engaging in evaluation. Critical thinking requires students to consider carefully and then to make a judgement, or a critical or moral response or appraisal of an object, a construct, an incident, issue, pattern of behaviour or artefact for use.

Teaching of innovation skills

When considering the teaching of innovation, creativity, critical thinking and problem solving, teachers need first of all to consider how these competences are related to each other and also what are the underlying skills and attitudes or dispositions that support the development of the competences.



Imagination:

Imagination is a key underpinning capacity for innovation. Imagination can be defined as the ability to form mental images of things not present to the senses, or being able to visualise in the realm of the mind. Part of the ability to imagine is to conceive of things that are unreal or even absurd. We can think of children, or even adults we know, as having a great 'imagination.' Since imagination is therefore an ability or a skill that can be developed, the question is how do some people develop it to a much greater extent than others? What activities, experiences or learning contribute to imaginative development? The answer lies in the range of experiences to which learners have been exposed in their formative years, and how this capacity continues to be developed throughout the whole of their lives.

Relationship to curriculum

The relationship between imagination and creativity has been very well described in development psychological and educational research since the 1930s, when Vygotsky first suggested that imagination in adult and adolescent life was directly related to pretend-play as children. His theories are summarized in research as follows:

1. Imagination is the internalization of children's play.
2. Imagination is a higher order-thinking skills and, as such, is a consciously directed thought process.
3. Creative thinking involves the collaboration of imagination and thinking in concepts, which occurs first in early adolescence but mature in adulthood.

Thus, the school has a critical role in ensuring that children at all grade levels in elementary education have opportunities to engage in suitable forms of pretend or imaginative play. Most subjects offer occasions for students to engage in imaginative thinking, especially the arts, creative writing and responding to stories, visual arts, drama and music.

Creativity

Creativity can be described as the ability see new patterns and relationships and connections between things, to make connections between things that are seemingly unrelated and this in turn leads to generating solutions to problem solving. Creative artists, for examples, are often concerned with finding novel ways to communicate ideas or experiences, whether through visual media, drama or music. From the classroom perspective, there are both cognitive and affective dimensions to creativity. On the one hand, students need to be constantly developing knowledge by engaging in knowledge-building activities and applying their knowledge perceptively in reasoning and problem-solving activities.

As well as the cognitive dimensions of creativity, imaging, visualizing, comparing and reasoning there are also affective dimensions, including risk taking, persistence and perseverance. The levels to which children develop the affective traits are also highly responsive to home, school and classroom influences.

Relationship to curriculum

A useful framework within which to reflect on the relationship between imagination and creativity is that creativity draws on the well or the resources of the imagination to generate innovative thinking that leads to solving problems and improving processes and products. Thus, creativity employs imagination to address a challenge and solve a problem. So if we think of imagination as the fuel for creativity, we need

to consider what the constituents of imagination are, and the activities or resources that will lead to the development of imagination in the education context. Like many other aspects of human development, behavioural psychology has established through research that early learning experiences account for almost all of the differences in individuals' capacity to use their imagination.

The following are some of the influences of imaginative development:

- Experience – real experience or vicarious experiences through stories or pretend play
- Observation, noticing things, naming things, forming categories, making inferences and judgements about what is observed
- Asking questions
- Informal data collection (making mental notes)
- Making connections between things that have been observed,

All of these influences and experiences increase a person's capacity to acquire knowledge and manipulate knowledge to foster new understanding and make new or unexpected connections between things that have been observed. This is the beginning of what can be described as creativity.

Critical thinking

The ability to think clearly, logically and critically is at the heart of good education and underpins the foundations of innovation. In a world where knowledge is readily available, the ability to harness critical thinking skills to make the best use of knowledge is becoming a key focus of education. Critical thinking can be described as a process leading to the ability to make reasoned judgements and draw logical conclusions from information, facts or objective evidence. There are many activities at all stages of education that support the development of critical thinking skills, from sorting, matching and classifying activities in KG classes that lead to children's development of the ability to discriminate in a concrete manner, to formulating and testing hypotheses in science classes and engaging in reasoned debate and argument in social studies classes. Ultimately, critical thinkers can articulate a point of view and support it with reasoned argument and empirical evidence, but they can also maintain a degree of scepticism about issues that leads them to question facts and evidence and perhaps change their position in the light of new evidence.

Relationship to curriculum

Critical thinking skills can be integrated in almost all subjects across the curriculum. There are many different dispositions, attitudes and skills that support the development of critical thinking.

The following list represents a continuum of critical thinking skills that might be taught through a range of subjects:

- Listening, describing, categorising and comparing are critical thinking activities that can be developed through language, mathematics, science and social studies lessons from the earliest stages of first level education
- Questioning, reasoning, clarifying, analysing and clarifying are skills more likely to be developed in upper primary and secondary education
- Summarising, synthesising, reflecting and evaluating are towards the top of the hierarchy of critical thinking skills and feature strongly in second-level education

Among the many dispositions that schools should seek to develop in students to support their development of critical thinking, curiosity and a questioning attitude are crucial. Curiosity will prompt students to critically examine and compare issues, while healthy scepticism about conclusions presented to them will lead them to suspend their final judgement until the force of evidence is overwhelming. Students need to be taught that information needs to be tested for accuracy and the need to learn how distinguish between facts and biased argument and ill-founded opinion. Media and advertising provide rich sources of examples of how facts can be persuasively manipulated.

Strategies to help with critical thinking skills

(Cognitive Strategies - Micro-Skills)

1. comparing and contrasting ideals with actual practice
2. thinking precisely about thinking: using critical vocabulary
3. noting significant similarities and differences
4. examining or evaluating assumptions
5. distinguishing relevant from irrelevant facts
6. making plausible inferences, predictions, or interpretations
7. giving reasons and evaluating evidence and alleged facts
8. recognizing contradictions

9. exploring implications and consequences

Problem solving

Problem solving, whether in mathematics, science or making logical inferences from written material, draws on many of the skills and personal qualities encompassed by the innovation framework. Problem-solving requires persistence and resilience, the ability to see patterns, relationships and connections and the use critical thinking and problem-solving strategies. Developing students' problem-solving ability in the education context is most frequently associated with mathematics, but is also present to a growing extent in science and technology-related activities. Problem solving can be a highly fulfilling individual activity but group problem solving contributes to students' development of interpersonal, communication and collaboration skills. It can be argued that ultimate aim of education is to equip students with problem-solving skills that will help them to make good decisions throughout their lives. Therefore, teaching generic problem solving skills and strategies is a key component of developing students' innovation skills.

Relationship to curriculum

At all stages of education and in every subject areas, opportunities arise for teachers and students to discuss problems and solutions. Stories that students encounter in reading material are frequently based on the resolution of problems encountered by the main characters. In social studies, history and geography, themes and subject matter often address contemporary environmental and social issues in term of shared global challenges. For younger children, problem solving activities are best contextualized in the situations that are most familiar to them – the home, the classroom and the immediate environment. Initially, presentation and discussion of problems can arise informally as children play or are engaged in learning tasks and activities. As children mature, they can be introduced to collaborative approaches to problem solving, for example, through whole-class or group brainstorming sessions.

Students' problem-solving skills and experience will be develop as a result of practice in working with different types of problems. Ultimately, they are more likely to become successful if they have a consistent, strategic approach to tackling every problem.

Strategies to help with problem solving:

Learners need to appreciate that the solution to a problem will not always be readily apparent and that they may need to apply a range of strategies to finding the solution to a problem. They also need to understand that problem solving relies largely on effort, persistence and resilience rather than flashes of brilliance or inspiration.

What do you know? (Write down the problem. Underline the key pieces of information in the problem that will help you to find the solution. Cross out any information that is not needed to find the solution).

What are you asked to find or show? (Highlight the question that the problems seeks to answer)

Can you restate the problem in your own words?

Can you represent the problem by making a picture, diagram or model? This will help you to better understand the problem.

A comprehensive description of strategic approaches to problem solving entitled *Introduction to Problem-Solving Strategies* can be found at the website [https://us.sagepub.com/sites/default/files/upm-binaries/21113_Chapter_1_from_Posamentier_\(Problem_Solving\).pdf](https://us.sagepub.com/sites/default/files/upm-binaries/21113_Chapter_1_from_Posamentier_(Problem_Solving).pdf). The following strategies for solving problems are recommended and are illustrated using examples at varying levels of difficulty

1. Working backwards
2. Finding a pattern
3. Adopting a different point of view
4. Solving a simpler, analogous problem (specification without loss of generality)
5. Considering extreme cases
6. Making a drawing (visual representation)
7. Intelligent guessing and testing (including approximation) 8. Accounting for all possibilities (exhaustive listing)
9. Organizing data
10. Logical reasoning

Useful websites

<http://nzmaths.co.nz/problem-solving-information>

<https://www.mathsisfun.com/>

<http://nrich.maths.org/10341>

<http://illuminations.nctm.org/Lesson.aspx?id=798>

<http://www.amanda-warner.com/samples/puzzles/goosefoxcorn.html>

<http://www.criticalthinking.org/>

<http://www.p21.org/>

http://www.amdro.org.uk/SiteCollectionDocuments/Learning/Subjects/ICT/Skills_Framework.pdf

Measuring Innovation Skills Standards

Descriptors

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Measuring Innovation Standards: Imaginative and Creative Learning Skills

Mastery: Independent use of skills in learning.	<p>Students own, recognise and make appropriate use of competences relating to divergent thinking (a thought process or method used to generate creative ideas by exploring many possible solutions) as part of a range of skills to generate ideas/material, scope projects, diversify content, broaden range and multiply reference. Students are well-practised in assimilating a wide range of different ideas, materials, areas, aspects, styles and approaches into well-crafted constructs whose form appropriately reflect the meaning, genre, purpose, audience of the finished work.</p> <p>Students elaborate material/ work towards a refined end product with an organic connection to its starting points. The process has added value to learning and acted as a structured springboard promoting achievement that is a formally pleasing construct of new out of old.</p>
Developing: Less structure required.	<p>Students work on tasks that promote active capacity and confidence to integrate wide-ranging (even unexpected) links and connections – concrete/abstract – as a routine feature of working independently to complete tasks. Students demonstrate a conscious awareness and appreciation of the role of brainstorming and divergent thinking strategies as preliminary to creative and productive activities. It is embedded in student learning styles and analytical processes.</p> <p>Students' presentations, investigations, projects and constructs draw on and effectively integrate a wide range of study skills, learning styles, methods, materials/content disciplines as fit for purpose in establishing and/or constructing complex links and/or connected ideas.</p> <p>Students demonstrate clear grasp of form, shape, pattern, genre, tone, idiom, culture or context, etc. with regard to how the final outcome relates to its stimulus or starting point to aid understanding Projects/Tasks and challenges based on elaboration work towards a completed product.</p> <p>Students use a variety of approaches to planning, problem-solving, analysis and investigation; they establish a context for approaches to be used in tasks and creative challenges.</p> <p>Students make use of planning tools (e.g. concept maps) to generate ideas, connect and group them into linked areas and overall structures (e.g. project matrices) to shape a final product. Work shows good use of visual, numeric, written and other learning styles to promote meaning.</p> <p>Students use taught study-skills independently in recording and planning complex topics, projects, investigations and to establish links and structure outcomes (e.g. matrices). They make effective use of ICT and multi-media approaches enhance meaning and communication. Students' participation in paired, shared and group work which adds complexity and depth to final task outcomes. The use of compare/contrast and combine tasks for example extend learning and perspective.</p>
Growing independence	<p>Curriculum areas promote subject-specific and interdisciplinary links, connections and areas of integration. Students begin to make more abstract and/ or conceptual joins, connections/ integrations. Students' use of divergent thinking is supported by the provision of a range of methods skills, techniques tools, approaches and materials to select and adapt in completing tasks.</p> <p>Students increasingly respond to tasks requiring more than a single, correct, (convergent) answer independently. Multiple question raising or finding is a feature of critique, analysis, review, response and task summary (plus diversity of answers).</p> <p>Students are developing contexts for and ability to use free improvisation techniques drawn from stimulus material – e.g. poems inspired by paintings, role-play drawn from characters in text. Cultural/context adjustment e.g. Goldilocks and the 3 camels. They create posters to illustrate math or science topics.</p>
	<p>Students are adept at brainstorming techniques in individual, group and class contexts. They demonstrate growing capacity to plan/shape by multiplying ideas and methods from starting points to later stage. They demonstrate some independence in divergent thinking strategies/routes to solve problems and address tasks.</p> <p>Concept mapping techniques help students visualize, record structure, and make connections via multi-disciplinary study skill method. Students demonstrate the growing ability to develop and add to starting points as a study skill and learning tool – e.g. refine brainstorm to ride on back of ideas to extend and develop thinking.</p> <p>Students choose and make use of preferred learning style, from the range the task or activity offers, in application of techniques, styles, genres to elaborate and construct work/ task.</p> <p>Activities invite de-contextualized thinking (e.g. placing character from a story in another situation 'Goldilocks has lunch with Little Red Riding Hood'). Use the tone or register of 1 situation in a different one – e.g. write school rules in style of menu.</p>

<p>Individual and group activities produce a range of input and/or solutions to problems (e.g. trial approaches). Purpose-specific record methods modelled and used - spider diagram, matrix grid - and students routinely find as many ways or methods to complete task/work.</p> <p>Students able to extend basic ideas, problems, challenges into more developed concepts, plans, oral or written explanations (e.g. how to weigh an elephant? how to make the school eco-friendly? design a logo communicating school mission). Develop e.g. 4 digit number sequence.</p> <p>Writing tasks that invite integration of parts (e.g. think of different ways you might use a chair; objects in your environment you might use as a seat). Using given numbers and items (e.g. shape tiles) to make a design (e.g. floor tile) or mobile (e.g. for nursery). Use given apparently random clues or fragments to solve mystery Encourage alternatives and perspectives/view-points through the use of activities like identifying/listing multiple-usage and application - 'how many uses for?' 'how many ways can?' (how many ways can you make make 7? etc.). Give selected yet disconnected objects to use in narrative structures or art compositions or pattern sequences etc. Students 'find' items to link (how is a cow like/unlike a whale?).</p>	<p>Questions/tasks promote divergence as well as convergence ('how many? 'find the most', 'try 5 ways to' etc.). Basic (structured) investigations require and record multiple answers/outcomes. Students given and use tools to generate response - which/what/why?</p> <p>Activities routinely require and establish cross-curricular connections. Problem solving and making encourage ingenuity and adaptation (lateral thinking) around materials/approaches. Questioning and activity regularly ask for itemization and exploration of similarity and difference.</p> <p>Questions, tasks, challenges, problems are sufficiently open-ended to promote and value individuality of response and to be celebrate them alongside correctness.</p> <p>Activities promote 'out of the box' perceptions - e.g. word pictures and changed narrators,</p> <p>Students allowed and encouraged to use given materials in a range of ways to make many objects. Questions and activities initiate or require a lot of responses (not just one) from each student e.g. movements to music; creating pictures or designs to represent their thinking. Work stations and role-play areas prompt multiple usage.</p> <p>Students given a diverse range of materials freely to investigate/connect and explore. A rich 'imagine if' multi-sensory resource encourages role-play, making and dressing up and the imaginative use of objects/ artefacts in representational play. Curriculum and questioning invites students to see links.</p> <p>Students given starting points to build on which are structured but not predefined (e.g. artwork or making tasks to embellish and/or work-up/add to completion NOT colouring-in). Develop and extend sequences e.g. of movement/rhythm or broad character in role. Add steps or elements to repetition activities/games.</p>
Emerging: Often needing a clear structure and steer	Acquiring skills and confidence

Measuring Innovation Standards: Critical Thinking and Problem Solving Skills

Component	Analysis (To scrutinize and enquire; to break down wholes into units/parts of meaning or components; to clarify relationships, structures and/or communication practices. To investigate)
	<p>Students routinely and habitually use close analytical approaches as a learning tool and as part of their mature sense of responsibility for their own learning and the secure validation of their own conclusions. Open investigations of many variables are aptly done.</p> 
	<p>Students draw on a range of analytical techniques to support independent investigation, comparative analysis and the isolation/identification of textual effects, meaning-making/underlying patterns and/or significant trends in focus material.</p> 
	<p>Students inducted into a range of subject /area or task- specific analytical tools and mapping techniques to facilitate independent experimentation and investigation (e.g. critical path; GANT chart; mind maps; compare and contrast grids, work logs)</p>
	<p>Independent approaches to learning are supported by the provision of some analytical models and techniques to facilitate analysis of primary data and material (e.g. study matrices or SWOT analyses). Students support conclusions citing corroborative evidence.</p> 
	<p>Themed investigations of interest-based topics and longer-scale projects develop independent study skills and staged analyses from preliminary observations or findings through to final conclusions which are presented or recorded formally</p>
	<p>Texts and data of all kinds (written, visual, numerical and qualitative data, artefacts) are analysed freely following instruction in generic investigational techniques (text marking, cloze, colour-coding etc.) Paired and group investigations aid refinement and communication of conclusions.</p> 
	<p>Students begin to record their investigations using a variety of methods (sometimes on provided formats) and can suggest conclusions. Subject-specific enquiries (e.g. quantity, shape and space) enrich curriculum engagement. Free investigations develop curiosity.</p>
	<p>Opportunities to explore objects, materials -e.g. sand, topic resources enable students to experience and establish for themselves their characteristics and properties etc. This enquiry-based activity/ play should not pre-define outcomes but should be planned to limit random variables and so promote focus.</p>

Measuring Innovation Standards: Critical Thinking and Problem Solving Skills

Component	Application (An active learning process using acquired skills or knowledge learned to problem-solve; address challenges and/or devise viable solutions to open-ended questions).	Students create their own problem-solving pathways creating their own problem-specific criteria and devising approach(es) fit for purpose; drawing on and refining best methods of working towards self-identified and defined success criteria.	Students able to problem-find as well as problem-solve and to define these personal challenges and then scope-out these individualised problems for focused solution, including resource requirements and methodological best approach to guarantee viable/ effective solution.	Students show increasing ability to generate their own operational methods and/or success criteria against which to conduct set problem-solving activities and gauge the effectiveness of their solutions. For example, students decide how to test friction of varied objects and how to test result
Mastery: independent use of skills in learning.	Developing: Less structure required. Independent learning.	Acquiring skills and confidence Emerging: Often needing a clear structure and steer	The problem-solving focus now includes the identification (through active application to given problems) of best methods fit for purpose from a range of approaches (via the application of given criteria) and the choice of best solution (also via applied criteria)	Greater emphasis is placed on the generation and application of new, imaginative or lateral ways of solving problems and the fair testing of a variety of given or individually developed methods and approaches to solving a given problem.
			Problems are specifically worded requiring working for clearly stated reasons towards well-defined goals (e.g. devise a solution for safely getting on and off a camel) but invite some individuality of approach in producing a viable or satisfactory outcome.	Students practise and consolidate new as well as old skills and techniques in working towards specific goals (e.g. the handshake problem). There is an element of choice or flexibility in method of best approach to use or in recording of process and outcome (usually a correct solution)
				Students begin to work towards the solution of (typically closed) problems using a given task- appropriate set of materials or skill-set(s) provided through prior instruction and where necessary, ongoing support and encouragement and prompting towards a correct solution

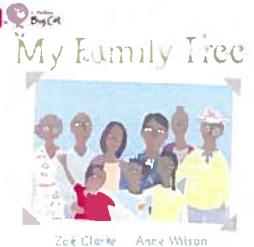
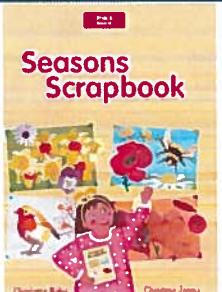
Measuring Innovation Standards: Critical Thinking and Problem Solving Skills

Component	Evaluation
	To consider carefully and then to make a judgement, or a critical or moral response or appraisal of an object, a construct, an incident, issue, pattern of behaviour or artefact for use. To ask ‘what if’, question the source and validity of information or findings, be aware of bias and vested interests
	A healthy culture of evidence-based assessment and evaluation prevails at class, group and individual level in which the critique of information, knowledge, conclusions and evidence underpins active, defensible, opinion-forming and persuasively argued, justifiably held viewpoints
	Students are less reliant on teacher-designed rubrics, writing frames, scaffolds or evaluative tools and make independent use of an appropriate range and repertoire of evaluative approaches in extended writing; data analysis; formal appraisal; apt presentation; plausible/balanced and justified judgements
	The evaluation of method, working practices, materials, fitness for purpose is both more secure and nuanced as well as routinely used in personal planning activities (e.g. SWOT analysis) to improve outcome and in assessing their success or effectiveness.
Mastery: independent use of skills in learning. Independent ownership	Students draw on their background in evaluative work to inform their independent judgements in open-ended tasks with more complex or ambiguous moral, social, aesthetic or procedural implications (eg character or text appraisal; weighing advantages against disadvantages, benefits against cost)
Developing: Less structure required. Growing independence	As for ‘emerging’ but more random variables, and/or complexity (e.g. tangrams). Some basic conceptual integrations (e.g. combine material or PE movements with a theme). Making similes and metaphors in words and images. Make some non-literal or abstract connections.
Emerging: Often needing a clearer structure and steer	Students are routinely asked or tasked to make evaluative/ ranked comparisons of two items via structured criteria or format (e.g. graphical tools such as pro/con or good for/bad for grids), regarding judgements such as, respective usefulness, merit, success.
Acquiring skills and confidence	More abstract evaluations based on focus material (e.g. is Goldilocks a good girl or not?). Students use given simple criteria to assess objects, methods, own work, materials and processes, etc. Role-play incidents (such as student/ teacher) where judgements are made explicit.
	Basic evaluative questions with regard to concrete curriculum content stimulate judgement making (e.g. did you like this book? Why?). Listing or grading activities such as favourite fruits; foods liked and not liked; best playground games (always asked for reasons why).

Exemplars

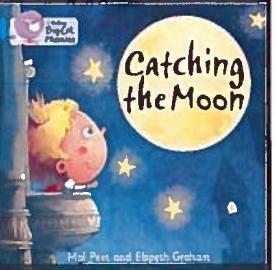
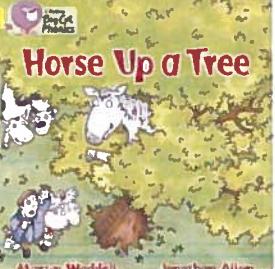
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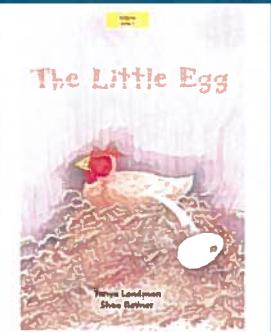
Exemplars

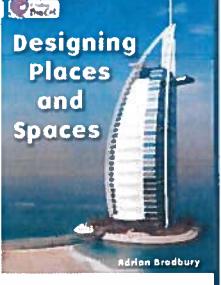
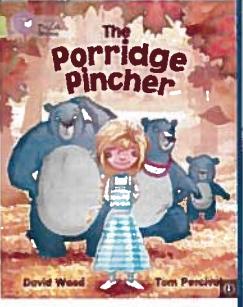
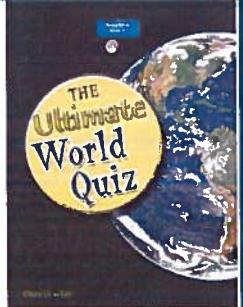
Innovation Skills							KG Subject: English	Suggested Resources	Picture
Collaborating	Communicating	Critical Thinking	Problem Solving	Creating	Innovating	Learning Outcome(s)	Pedagogy		
						describe familiar objects with detail	Teacher is to provide each student with an All About Me Bag which includes a parent letter. Each student takes the bag home and fills it with five personal items. Students are to bring the items to school and present them to the rest of the class using the sentence starter, "This is my.....". The rest of the class is to ask questions that will allow the student to describe their items in more detail. Once presentations have concluded, the students are to sort the class's items according to size and/or colour.	Book title: My Family Tree Publisher: Collins Big Cat Reader	 Zoë Clarke Anne Wilson
						generate and expand ideas through shared and guided prewriting	Teacher is to inform students that they are going to write a class book about vehicles for different purposes. As a whole class, students are to work together and use their problem solving skills in order to design a vehicle with wheels for each of the following purposes (a vehicle to get through deep sand, a vehicle to drive in heavy rain, a vehicle to get to school really fast, a vehicle to drive on ice). Teacher is to record the ideas of the students during shared writing so that the class creates a class book	Book title: Wheels Publisher: Collins Big Cat Reader	
						share their writing with teacher and peers	Teacher is to provide each pair with a scrapbook template so they can work together to create a scrapbook about their classroom. Using the template We'll find..., students include a picture and a key word/s taken from environmental print (e.g. We'll find a book). Once completed, students are to present their scrapbook to the class and listen to each other while sharing their writing.	Book title: Seasons Scrapbook Publisher: Collins Big Cat Reader	

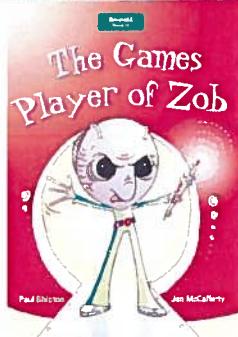
Innovation Skills

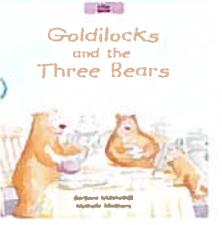
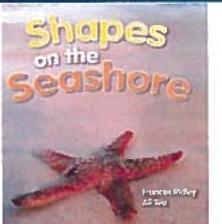
(Cycle 1/ Lower Primary)

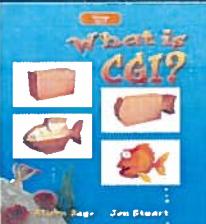
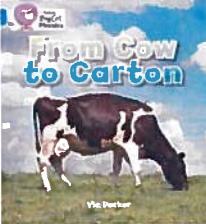
Subject: English									
Collaborating	Communicating	Critical Thinking	Problem Solving	Creating	Innovating	Learning Outcome(s)	Pedagogy	Resources	Picture
						plan a project collaboratively with a team by listening and responding to the ideas of others	Teacher is to provide small groups with a kit including the following items: pipe cleaners, coloured squared paper, cello tape, foam shapes, netting, string, straws and play-dough. In groups students are to work together as a team to complete a planning card to determine roles and responsibilities. Students are to share ideas and listen to one another while developing a plan of action to construct a device they can use to catch the moon. Students are to present their device to the class and complete a reflection card. The presentation must include a description of how they have worked collaboratively .	Book title: Catching the Moon Publisher: Collins Big Cat Reader	
						generate and expand ideas through talking to peers, teacher and look for ideas in personal experiences during prewriting	Teacher is to facilitate a discussion with the whole class about the difference between fiction and non-fiction and the importance of imagination and creativity. Teacher asks students to form small groups. Students are to work together and use their problem solving skills to determine how they think the horse got up the tree. Students are to share and listen to one another in their initial brainstorming session where they are required to record first thoughts, expand on their initial ideas in order to identify how they believe the horse got up the tree. Students then present their ideas to the class.	Book title: Horse Up a Tree Publisher: Collins Big Cat Reader	

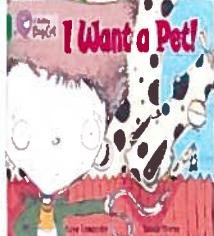
2SLLT3	Plan a project collaboratively with a team by listening and responding to the ideas of others	<p>Teacher is to ask students to work together in small groups to design an item that they believe will not 'crack' if it rolls down a hill. Students are to establish roles and responsibilities to complete the task. Once the design is created, students hypothesize the outcome, carry out the test and record their findings. After completing the test, students are to present their design, hypothesis, results and any changes they would make if they were to design another item.</p>	Book title: The Little Egg Publisher: Collins Big Cat Reader ADEC English Reading Scheme: Reading Time	
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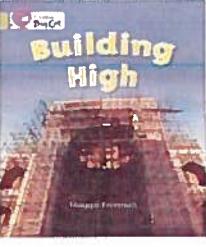
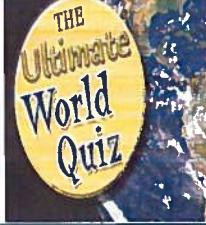
Innovation Skills						(Cycle 1/ Upper Primary) Subject: English			
Collaborating	Communicating	Critical Thinking	Problem Solving	Creating	Innovating	Learning Outcome(s)	Pedagogy	Resources	Picture
						plan a project collaboratively with a team and share the process and the result of the work with familiar and unfamiliar audiences.	Teacher is to inform the whole class of the Grade 5 'School of the Future' competition. Teacher is to provide small groups with a planning document and a Lego kit. Students are to work together as a team to complete the planning document which includes determining roles and responsibilities, generating ideas and planning and constructing a school of the future. Students must incorporate new ideas that will innovate the current way schools are built.	Book title: Designing Places and Spaces Publisher: Collins Big Cat Reader	
						ask clear questions and follow up questions	Teacher is to provide small groups with character cards (Goldilocks, Father Bear, Mother Bear and Baby Bear) and the definition of closed and open-ended questions. Each student in the group draws a character card. Students are to adopt the persona of the card they have drawn and write open-ended questions that they would like to ask the other three characters. Students are to take turns sitting in the 'hot seat', listening and responding to the questions that are being asked of their character.	Book title: The Porridge Pincher Publisher: Collins Big Cat Reader	
						plan a project collaboratively with a team and share the process and the result of the work with familiar audiences.	Teacher is to provide each small group with an instruction card. The instruction card indicates that students are required to allocate roles and responsibilities to help develop a process for working together so they can plan a trip around the world. Students use their problem solving skills in order to adhere to the following requirements (visit 4 locations in 16 days spending 3 days in each location). Students work together to plan their trip and create an itinerary. Teacher is to encourage the students to use appropriate travel websites,	Book title: The Ultimate World Quiz Publisher: Collins Big Cat Reader	

							along with the information from the text. Once they have completed their itinerary, one group is to meet with another group to share their itinerary and communicate the process they used to achieve their itinerary.			
							evaluate texts for author's purpose, points of view, characterization, setting, plot	Teacher is to ask students to work collaboratively in small groups to create a game including features of the text (purpose, characters, setting, plot and structural elements). Teacher is to provide each group with success criteria outlining the requirements for the creation of the game. Students then swap games with other groups so that they play each game that has been created. Once students have played the games, they are to work collaboratively to evaluate each game, determining which game is their favourite with a justification based on the success criteria .	Book title: The Games Player of Zob Publisher: Collins Big Cat Reader	

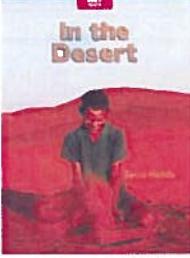
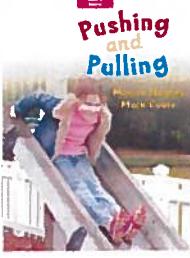
Innovation Skills						KG Subject: Maths			
Collaborating	Communicating	Critical Thinking	Problem Solving	Creating	Innovating	Learning Outcome(s)	Pedagogy	Resources	Picture
						represent quantities from 1-10 using concrete materials	<p>Teacher is to arrange a small group into a circle and provide group with a set of picture cards and digit cards (1-10). Students take turns to turn over the digit card and match the card to the correct number of picture cards. For example, if the student turns over the digit card 3 they must select 3 chair picture cards. The student is to count the number of chairs, sharing their answer with the group.</p> <p>Students repeat activity using the other picture cards of the beds and bowls of porridge.</p>	Book title: Goldilocks and the Three Bears Publisher: Collins	
						manipulate, identify and sort familiar 2D and 3D shapes in exploration and play and recognise them in everyday contexts	<p>Teacher is to arrange students into groups of 6 and provide the group with a set of picture shape cards. Students are to find a space on the carpet and draw a picture card from the pack and show the group. Using their collaboration skills and problem solving skills to students create the shape with their body / bodies.</p> <p>Students repeat until all shape cards are drawn.</p>	Book title: Shapes on the Seashore Publisher: Collins	

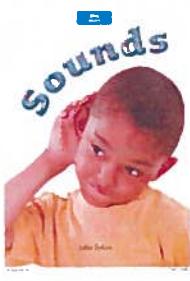
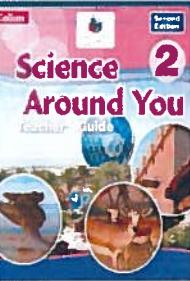
Innovation Skills							(Cycle 1/ Lower Primary) Subject: Maths		
Collaborating	Communicating	Critical Thinking	Problem Solving	Creating	Innovating	Learning Outcome(s)	Pedagogy	Resources	Picture
						construct a range of 3D solids using a variety of tools and describe the 2D faces	Teacher provides each pair of students with "60" cm cubes. Students collaborate to create a 3D object using the cubes. Students are challenged to construct an innovative object using all of the 60 cm cubes. Once completed students are to describe the 2D faces that appear on the 3D objects they have constructed .	Book title: What is CGI? Publisher: Collins Big Cat Reader	
						give and follow directions to familiar places	Teacher is to provide each group with a Bee-Bot and a Mat of a farm (cow field, milking shed, barn, farm shop). Teacher is to provide each group with instruction cards that include a set of generic directions (go straight, turn left etc). Students choose a starting and final destination. Student A must solve the problem of how to get to the final destination using at least 3 instruction cards and communicate the directions. The rest of the group collaboratively program the Bee Bot to follow the directions to reach the destination.	Book title: From Cow to Carton Publisher: Collins Big Cat Reader	
						1NWN12 manipulate UAE money, identify the value of different UAE coins and notes, order coins and notes and simulate making purchases	Teacher is to set up shops around the classroom using shop signs and tell the class they are going shopping for their mother because she is having a party. Teacher is to designate shopkeepers and customers and allocate badges. Shopkeepers have priced items to buy in their shops and play money. Students have shopping lists of items they will buy and play money. Students who are customers move to the shops in the classroom and the shopkeepers assist the shoppers. Students use their communication and problem solving skills to buy and sell the	Book title: Let's Go Shopping! Publisher: Collins Big Cat Reader	

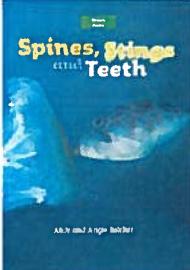
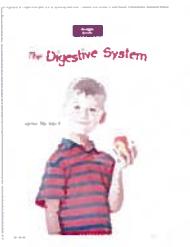
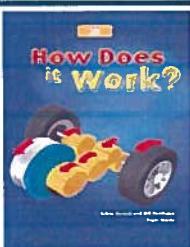
						items in the shop.		
						<p>make 'I notice' statements about a graph, including comparisons within the statistical inquiry cycle</p> <p>In groups, students conduct a survey in a small group and create a graph about their preferred pet. Pet choices will vary amongst the groups. Students are to write questions about the information from the graph. Students collaborate with another group in order to describe and compare their graphs.</p>	<p>Book title: I want a pet!</p> <p>Publisher: Collins Big Cat Reader</p>	

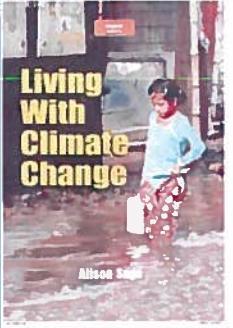
Innovation Skills							Grade (Cycle 1 Upper Cycle 1) Subject: Maths	Resources	Picture
Collaborating	Communicating	Critical Thinking	Problem Solving	Creating	Innovating	Learning Outcome(s)	Pedagogy		
						select and justify appropriate units and estimate, measure and record length	Teacher is to inform the class that Abu Dhabi needs talented engineers and that they are going to be part of a Grade 5 inter-class challenge to build the tallest free standing structure. The teacher is to divide the class into teams, each with 4 - 6 members and provide each group with a success criteria card. The groups are to allocate roles and plan how they can build the tallest tower. The students work collaboratively and use their creative skills to build an innovative structure using straws and sticky tape. Students complete the reflection cards for self-evaluation. The group with the tallest structure in the class goes through to the final round, where the tallest structure is chosen from all Grade 5 classes.	Book title: Building High Publisher: Collins	
						round numbers with up to 3 digits to the nearest 10 or 100 using a number line and justify rounding in terms of closeness to the number	Teacher is to inform the class that Adrian the alien has a problem. He lives on Mars and that as the temperature on Mars is -55 degrees, it's too cold and so he wants to move to a much warmer planet. Using the information from the planet fact cards, students are to collaborate in order to round the temperature of each planet to the nearest 100. Students mark this number on their blank thermometer sheet. Students are to order the planets from hottest to coolest. Students have to solve the problem of which planet they think Adrian would like to live on.	Book title: Let's Go to Mars! Publisher: Collins	
						construct simple timetables	In small groups, students are to listen and share ideas in order to choose 4 locations from the text to go on a 16 day trip. Using a travel website, students are to work together in order identify and record flight times between each	Book title: The Ultimate World Quiz Publisher: Collins	

country ensuring they spend 3 days in each location. Students are to create a timetable for the flights **solving the problem** of how to travel between the countries in the desired timeframe.

Innovation Skills						KG1 – KG2 Subject: Science			
Collaborating	Communicating	Critical Thinking	Problem Solving	Creating	Innovating	Learning Outcome(s)	Pedagogy	Resources	Picture
						identify features of the natural environment	Teacher is to provide each group with a Desert Diorama Kit (glue, crayons, markers, paint, paintbrushes, construction paper, scissors, play-dough, toothpicks, pipe cleaners, shoebox, tissue box and cotton wool). Students work collaboratively to design and construct a desert habitat. The desert diorama is to include all natural features of that environment. Students are to present their diorama to class.	Book title: In the Desert Publisher: Collins Big Cat Readers	
						identify actions on objects as pushes or pulls	Teacher is to provide each group with push and pull cards. Students will collaboratively investigate objects in the classroom using a push and/or pull motion. They will use their critical thinking skills to classify the objects as push and/or pull. Students communicate their findings to the class.	Book title: Pushing and Pulling Publisher: Collins Big Cat Readers	

Innovation Skills						(Cycle 1/ Lower Primary) Subject: Science			
Collaborating	Communicating	Critical Thinking	Problem Solving	Creating	Innovating	Learning Outcome(s)	Pedagogy	Resources	Picture
						classify features of the natural environment and the built environment	Teacher is to inform the group that they will take a walk around the school playground. Students work collaboratively to identify features of both the natural and built environments. Students classify their items into groups and communicate their findings to the class.	Book title: Around the World Publisher: Collins Big Cat Readers	
						describe basic properties and behaviour of sound	Teacher will ask students to work collaboratively in small groups. Students investigate sounds by testing different objects that are made from various materials (coin, eraser, bell, book, pencil, ball, bunch of keys, music triangle). Students test the sounds of each object and apply their critical thinking skills to record their observations. They describe the property and behaviour of each sound that the objects produce as they communicate their findings to the class.	Book title: Sounds Publisher: Collins Big Cat Readers	
						describe weather features and how they change from place to place.	Teacher will inform the students that they are going to collaboratively create a weather station using a variety of scientific equipment. Students will observe and record the various weather conditions for two weeks. They will create a weather diary to record different weather patterns observed. Students will compare their findings with another country whose weather features are different to the UAE (Canada, US, Finland).	Book title: Science Around You Teacher's Guide, Grade 2 Publisher: Harper Collins	

Innovation Skills						(Cycle 1/ Upper Primary) Subject: Science			
Collaborating	Communicating	Critical Thinking	Problem Solving	Creating	Innovating	Learning Outcome(s)	Pedagogy	Resources	Picture
						explain the characteristic of animals that help them to interact, grow and survive in their environment	Teacher will provide each group with different coloured mats and multi coloured squares. In teams students race to collect as many coloured squares as they can on each coloured mat. They critically analyze results by comparing tallies of the various hunts. Students communicate their results and discuss how their findings relate to the concept of camouflage.	Book title: Spines, Stings and Teeth Publisher: Collins Big Cat Readers	
						describe major body systems and their functions (circulatory, respiratory and digestive)	Teacher provides students with materials to build a digestive system model. In groups, students collaborate to create the complete digestive system found within the human body. Students communicate and summarize the functions of each organ. Students apply their problem solving skills in order to place a 7-meter long string, representative of a life size digestive track, into their digestive system model.	Book title: The Digestive System Publisher: Collins Big Cat Readers	
						explain the causes and effects of friction, including air and water 4S6 carry out a fair test	Teacher provides students with a K'Nex Intro to Simple Machines Gears Set and challenges them to create their own car. In groups, students collaborate and use their problem solving skills to carry out a fair test on how the how different surfaces affect friction and the speed of the car. Students investigate, observe and record which surfaces cause the greatest amount of friction and discuss their findings. Students reflect on their innovative designs and how they can be improved to resist friction.	Book title: Things That Work Publisher: Collins Big Cat Readers	 

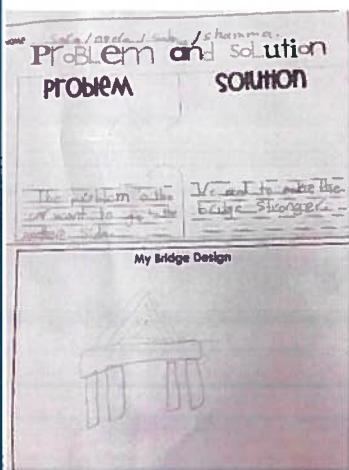
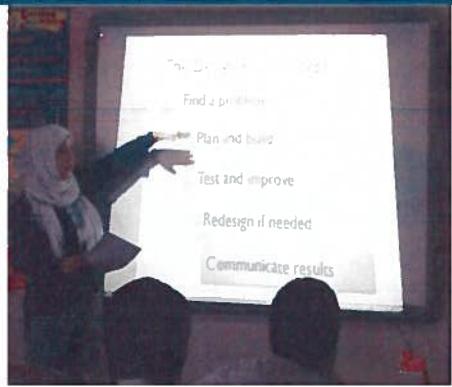
						identify and evaluate how human actions threaten the abundance and survival of living things within the ecosystem	Teacher will provide each group with a giant dice containing problem and solution cards relating to climate change. In groups, students collaboratively communicate how human actions effect climate change and find solutions to these problems. Students use critical thinking skills to determine how human actions can reduce the effect of climate change (carbon footprint).	<p>Book title: Living with Climate Change</p> <p>Publisher: Collins Big Cat Readers</p> 

Case study

Case Study:	Bridge building
Grade Level	Grade Three

Teaching Innovation – Primary

A bridge building science unit of work has led to Grade 3 students at a school in Abu Dhabi developing innovation skills, alongside other competences including problem solving, critical thinking and collaboration / teamwork. Their teacher used the design process to support the students learning. Students started by looking at examples of famous bridges, talked about what problem these bridges helped solve, and discussed what makes a good bridge.



The next step was to plan their own bridges. They worked in groups to draw a design of their bridge. They had to consider the range of materials they were given. Students then built their bridge and their teacher reminded them to always remember the problem they were solving, and to check their construction back against their design.

Test and improve is an important part of the design process and students did this using toy cars on their bridges. This testing helped them to make changes to their bridge, and in most groups they made sure that they modified their design drawing too. During this redesign stage the students were supported to analyse what they did to make their bridge effective through open questions from the teacher:

Why did you put these sticks here?
Why did you fold the paper?

How does this part make the bridge a better bridge?
Why did you add two more rods?

