STEM at C&K
(Science, Technology, Engineering, and Mathematics)
C&K acknowledges the Traditional Custodians of the lands on which our offices and centres across Queensland are located, and their continuing connection to land, sea and community. C&K also pays respect to all Elders - past, present and future.
Welcome to the first edition of Cascades for 2019. In this edition we feature authors reflecting on STEM in early childhood settings. C&K has a vision for children as:

- Powerful learners;
- Active Citizens; and
- Thinkers and Theorisers

Through embedding STEM within the curriculum educators are able to provide opportunities, experiences and environments that support this vision for children’s learning to come to life.

For further reading, you are able to access the C&K STEM Practice Guide here.

Happy reading
C&K Education Wellbeing and Inclusion Team

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Creating spaces for STEM

Tania Douglas
Director, C&K Rowes Bay Kindergarten.

I have always been very interested in how our environments provide children with opportunities to learn more about STEM. I have always been inquisitive, as there is always room to learn something new. In 2017 I applied to be part of the C&K STEM Community of Practice (COP) and was lucky enough to be accepted. I was in my element meeting with other like-minded educators, and came away with many light bulb moments. The biggest revelation was that STEM is a natural part of the kindy day. As the educator you just have to notice, and work to facilitate STEM learning in action.

Learning happens best when children begin by expressing wonder and an excited interest in their world. Being a part of the STEM CoP made me realise that it is the environments we provide for children that drive learning.

At C&K Rowes Bay kindy we are extremely lucky to have a natural bush kindy environment. Without any other equipment added children can be immersed in nature which, in itself is the perfect teacher.

There are times when you can plan for STEM learning, but I have found that the richest of STEM experiences come when you’re not prepared for it. Don’t let the ‘unpreparedness’ steer you away. It’s ok not to know the answers to the children’s questions; you won’t look silly in front of them. Finding the right open-ended question to ask or adding the right piece of equipment at the right moment is key. You don’t have to be a scientist, mathematician, engineer or technology expert to see these moments, but you do need to recognise when these moments are occurring. I am not a scientist, but I am an Early Childhood Teacher and I am inquisitive. When opportunities arise I don’t shy away from them even if I don’t have the content or concept knowledge, I learn alongside the children.

When educators learn alongside children you can feed and encourage their inquisitive nature. Intentionally developing a STEM rich environment within your educational setting gives your program ample opportunities to explore science, technology, engineering and mathematics on a daily basis. Use your environment, ask open ended questions, lead, interact, stand back, model enthusiasm and open-ended thinking, consider your children as strong and capable learners and embrace every STEM experience. This is demonstrated in the following stories.

1    |    C&K Cascades
The rain was pouring down this morning. We saw it coming out of the drain pipe but wanted it to go into the sand pit. Miss Tania got the old aqua track pieces out and we assembled them to see if we could get the water to run a different way.

Experiences such as this allow children to experiment with natural sciences, gravity, erosion, water flow, the motion of liquids and physics.

At yarning circle time we talked about rain. Miss Tania talked about how rain works. We talked about clouds, rain, evaporation, sun and rainbows. This is called the water cycle.

We sang ‘Rain, rain go away’ and ‘Incy Wincy Spider’.

We read ‘McGee goes to Sea’ by Pamela Allen.

When we sang Incy Wincy Spider we noticed that the water cycle was in the song. Science is everywhere, and we can learn about it while we play.
Cobah’s instructions “The instruction say this pole goes here and this pole goes there and this one here. You have to follow the instruction. We got to use these poles first then get a rope and then use a blanket. The blanket put it on top so you can have a sleep.”

“I can’t do it without the instructions. I need help.”

The children tried many different ways to put the material around for the walls. This was tricky cause they all had a different idea on how it was going to work. How were we going to find the best way? We decided to give each idea a go. We watched a time lapse video of a house being built. The video showed us all the stages of a house build from the foundations to the exterior painting. Now we know what a foundation is we need to make sure our tent has strong, stable foundations. We have learnt two new words today.
As a group we held a discussion on what we would like to give our father’s for father’s day. We narrowed it down to two things then had a vote on which one we would make.

Documenting a vote introduces children to data collection. For this vote, each child placed a sticker dot on their preferred option.

Dodam was building using the magnetic tiles. He used many different colours.

Miss Tania found a book about skyscrapers from her library. Dodam and Miss Tania looked at the pictures and found the ones that looked like Dodam tower. As they looked at the pictures Miss Tania and Dodam pointed out the things that were the same - square windows, colours etc. They found a picture of a tower with a pointy top. Dodam added a triangular tile on the top of his tower to make it the same.

What resources, people, space, ideas, environments and time considerations will best support learning?
My tips to provide a STEM rich environment from C&K Rowes Bay

Nature

We try as much as possible to leave our natural environment as it is. If a branch falls from a tree, we leave it etc. A large branch with palm leaves draped over it become a cubby house and an engineering experience. Turning over a rock opens a world of creature investigations. Nature provides so many opportunities for children to ask questions and delve into deeper investigations.

Loose parts

This would have to be the most important element. Items that can have many different purposes that are present in real life. Natural materials, recycled products, household and garage items, interesting containers, magnets, clamps, tarps, large pieces of material, rope and string. The list is endless and only defined by imagination. The most used resource in our shed would have to be a storage tub filled with old sheets, curtains and tarps. We have had some amazing structures built with them. An important component of exploration is imagination. Loose parts encourage children to think and be in control of their own learning.

Recording and researching resources

Paper, pencils, felt tip pens, crayons, clip boards, scrapbooks, magnifying glasses, bug catchers, digital cameras, iPads, digital microscopes and interactive screens. From Term 1 each year, I model how to document something of interest. I show the children how to access materials to document and then ensure these materials are available for them.

Reference books

Books on STEM areas, picture and story books, science experiment books, magazines on STEM topics, posters and websites displayed on the interactive screen. Some of the most amazing STEM experiences we have had at our kindy happen when children can freely research topics of interest.
Changing our mindsets in how we see maths to enable children’s curiosity

Dr Chris Martin

for further reading from Dr Chris Martin:

What multiple ways of doing and knowing will enhance children’s learning?
Creating strong foundations in STEM

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STEM in the early years has been associated with school readiness and academic achievement (e.g., Arnold, Fisher, Doctoroff, & Dobbs, 2002; Duncan et al., 2007). STEM engagement in these formative years goes beyond predicting success in just STEM related disciplines, to better language and literacy outcomes (Guernsey & Levine, 2015; Sarama et al., 2012). Essentially, it creates life-long learners (Sneidman, 2013).

Young children are capable and ready to engage in STEM learning (e.g., Baroody & Dowker, 2003). Studies suggest young children to be naturally curious, lending well to the investigation of STEM concepts (e.g., Tippett & Milford, 2017). They actively explore and investigate the world using all their senses from the moment they are born (Gopnik, Meltzoff, & Kuhl, 1999), and infants have been shown to test hypotheses when something does not conform to their expectations (Stahl & Feigenson, 2015).

Infants and toddlers have natural dispositions towards STEM learning. Very young children are curious explorers, use tools to solve problems and, when able, ask questions. It is this innate curiosity and the desire to test, learn and discover that must be encouraged. We do this by creating environments that encourage multisensory, open and focused explorations, and by asking questions (Hosington, 2010).

Incorporating STEM in infant and toddler programs can be done throughout typical, daily activities. Talking, reading and singing can help develop foundational STEM skills. We can use STEM language in everyday activities and actively participate in children’s play. Playing with toddlers with blocks, for example, allows for hypothesising, observing, creating, problem solving and measuring. Walking with infants and describing scenery, location and direction and discussing changing seasons also incorporates STEM.
The T in STEM is often overlooked when educating infants and toddlers. With screen time considered inappropriate for children up to 18 months and then only sparingly (Australian Government Department of Health, 2012), the T is often dismissed. As educators we need to look outside of digital technology. The T can be taken to mean something that is human made (i.e., any technology, rather than just a digital technology) and is used to solve a problem. When considering infants and toddlers, this could mean blocks, scissors, pencils or even food utensils.

Work done by the Early Childhood STEM Working Group (2017) highlights the importance of understanding the Big Ideas of STEM disciplines that are explored at young ages. For example, when children are touching and exploring objects, they are exploring the engineering principle of materials have properties that can be explored and described. Pushing items off benches allows for exploration of the science concept of events have causes. Knowing that morning tea is after an activity in their setting is the mathematical concept of pattern identification and rule application (pp. 30-31).

With infants and toddlers shown to be ready for STEM learning, it is during these early years that strong foundations in STEM can start.

References


In what ways are our teaching practices impacting children’s learning?

Is it STEM or STEAM?
I wonder...

Two simple words that unlock a plethora of possibilities that encourage investigation, inquiry, reflexive thinking and metacognitive learning. I have mused over this incredible phrase with Tracy Moir (Education Practice Advisor) and the impact it has when used frequently and consistently. We don’t always know the answers to our questions and sometimes there might not be a definitive answer. Wondering is the beginning of a journey that can take many different pathways and develop understandings across multiple scientific contexts.

During a professional conversation session with fellow educators, the most common concern resonating with most was that they are not scientifically minded, and struggle with teaching science to a cohort of birth - five year olds. STEM does not need to be taught, and you do not need to know the answers or have a catalogue of science experiments in your tool kit waiting to churn out when an interest presents itself. For example, primary colour mixing is a popular area of interest with young learners and it also provides an opportunity for those ‘creative/artistic’ thinkers to tap into scientific concepts. This does not need to be a structured, intentionally taught concept. Introducing the concept through stories such as “mouse paint” and the like, peaks the interests of young children and activates their thinking juices. Do not provide them with any further information that will intentionally redirect their own individual exploration of this concept, rather provide resources to support autonomous experimentation and inquiry. A discovery table with test tubes, clear containers, coloured water and droppers is all they need to construct their own understanding of primary and secondary colours. Step away from the exploration space and open your ears, listen to the language they use and document how their understanding evolves the more they explore the materials in front of them.

Belinda Poppelwell
C&K Seven Hills Community Kindergarten

The primary thought process behind learning & teaching is to stop overthinking it. You do not need to have a scientific background to develop confidence in your approach to STEM based pedagogical practices. If anything, it’s about breaking the mould of convention that most of us have been indoctrinated with during our own ‘old school’ schooling history. When you speak of science, one automatically defaults to intentional science experiments that have a guaranteed outcome/learning objective. Although bicarb volcanoes and colour jumping have a place in developing understanding of scientific principles, it does not assist young children to understand that we don’t always know the answers and what we think might happen isn’t necessarily going to be correct. STEM does not need to be ‘taught,’ rather observed and interpreted during a child’s play/investigation.

Open ended exploration using a broad range of resources and materials that we all have lying around in our storerooms promotes inquiry, problem solving, critical and metacognitive thinking. We do not need...
to outlay thousands of dollars purchasing resources. Our centre created an ‘optics’ exploration kit containing everyday items such as; torches, cellophane, reflective sunglasses, battery operated tea light candles, small mirrors, and a selection of spoons – all readily accessible and found cheaply at discount stores.

We set up an exploration table and encouraged the children to engage with the objects without providing them with any lead in on what optics is. After two days of exploring the objects, we asked the group if they knew what ‘optics’ was – I wonder? There were many ideas shared but we were still a long way from working out what optics was all about. Sitting with the children and observing as they placed tea lights under cellophane and observed their reflection in both sides of a spoon. We used open questions to get them thinking about the processes they were employing, their intention and their discoveries. They were not provided with answers, or intentionally led to a specific way of thinking; rather supported in their questioning and wonderings.

After two weeks of open-ended exploration, we asked the group again if they knew what optics was – I wonder. The ideas shared were rich with the language that they had been using during their investigations: “lights and mirrors,” “watching my face change in the spoon,” “making things,” and “watching things change colour.” They did not need a definitive teacher led explanation of what optics was as they were working it out for themselves. The children did not develop a deep understanding of this complex topic, but they didn’t need to because they had autonomously filled their tool kit with the skills of investigation, inquiry, and reflexive thinking. This is STEM. It required no effort or scientific understanding from us as educators, it was about providing opportunity for open ended exploration and discovery.

When we step out of the ‘play space’ and simply observe, we witness children employing STEM processes in everything they do. I watched one of my four-year olds work with his friends to fill some pots with water. The problem, there were no buckets available. He grabbed a straight PVC pipe and filled it from the tap. Carefully, he carried the pipe trying awfully hard to keep it level knowing that if he tipped it, the water would run out the ends. Despite his best attempts, when he got to the pot most of the water had trickled out en route. He returned to the mud pit and found another pipe that was ‘v’ shaped (two pipes joined with a connector piece). He explained to me that this pipe would be better as the sides go up and the water won’t drip out the ends when he carries it. Did I need to take this further? No. I simply basked in the joy of observing this four year old use problem solving, critical thinking and reflexive thinking as he constructed his own understanding of scientific concepts through his play. This did not need a follow on experiment, it simply needed to be documented for what it was, early STEM thinking. I wonder what I can use in place of a bucket, I wonder how I need to carry the pipe to keep the water in? I wonder why it didn’t work? I wonder what else I can use? I wonder…

What is this child curious about? What working theories is this child exploring?
Our passionate group of educators acknowledge that children have an in-born intellectual capacity and curiosity that needs time, space, variety of resources and contexts to support investigation. STEM has been part of this centre for many years, however, our colleague Lisa’s involvement in the C&K Community of Practice for STEM and her passion has heightened our awareness of and focus on STEM concepts.

To strengthen and deepen our understanding of the diversity of STEM we developed a centre STEM folder containing articles about STEM and STEM assessments from each educator. The multi-disciplinary concepts of STEM have been discussed within our group and broken down into poster form, the language related to each discipline was identified, collated and added to the file making this a comprehensive much used professional educational resource.

The work of Lilian Katz and Sylvia Chard (2000) resonated with our group and lead to our reconceptualising how we view our role in children’s learning. Both Katz and Chard focus on a project approach to learning, consider intellectual learning vs academic learning, address the life of the mind, the dispositions for learning and developing lively and inquiring minds. Both theorists believe curriculums help children make meaning of their world through a deeper and fuller understanding of their experiences. STEM conceptual learning flourishes in this environment.

Through the exploration of water, we have witnessed STEM related concepts spontaneously emerge in children’s play for all ages.
Fox (just four years old) at the water trough is testing and hypothesising on the properties of materials and the rate of water flow. ‘what will happen if I put it in - (adding a piece of sponge to a funnel) – Then announcing, “it made the water go slow!” An educator said, “what will happen if you used other resources?” Fox proceeded to experiment with various sized rocks, twigs, leaves and materials. He discovered that several resources slowed the flow of water, he announced, “just the little rock stopped the water not the big rock.” The adult said, “why did the little rock but not the big rock stop the water?” Fox continued swapping the big stone and the little stone and finally said, “cause the little stone fits!” (the little rock fitted into the spout on the funnel). Fox is reflecting adult role-modelled language of inquiry deepening his hypothesising and formulation of the STEM experience, the nearby educator strengthens his inquiry and lively thinking with a timely question bringing in maths concept of ‘fit.’

George (two years and four months) investigates the buoyancy of rocks and the concept of floating and sinking. He discovered that the pumice rocks floated while the coral rocks sank even though the rocks looked similar. Recognising the difference, he selected the pumice rocks, moved back from the trough and threw the rocks into the water, still they floated. Adding challenge he held the pumice rocks under the water for some time when he released them, they popped up. As George has little productive language a nearby adult supported the investigation by injecting questions, ‘I wonder why this pumice rock floats and this coral rock sinks down? Which one is heavier?’ (Adult used hands as a scale to evidence the concept of lighter/heavier). The holes in the pumice rock were indicated, investigated by George and compared to the coral rock that had no holes! George has been given time to scientifically (two year old style) experiment and interpret the geological structure of rocks, timely educator involvement has injected STEM language and used gesture to make visual the meaning of weight.
The flow of water
C&K Coolum Community Childcare Centre

Ziggy (not quite two years old) is outside watering the grass, a morning ritual. Ziggy observed the water shooting from the hose and falling to the ground. He walked to a reel nearby and utilised the centre to funnel and control the direction of the flow of water. After observing the water flow through the middle and experimenting by pushing the hose in and out of the reel noticing how the flow altered. He set the reel on its flat end and tried to fill the centre with water. He looked in the hole for a while then looked at the ground and the water spreading around. An educator asked, ‘what’s happening to the water, Ziggy?’ Ziggy looks at the centre hole, back at the water on the ground and says, “broken.” Ziggy is experimenting with physical ways to control/alter the flow of water, an educator framed a question of inquiry offering another concept to investigate.

Embracing the project approach has made us aware of the never-ending aspect of ‘learning outcomes,’ recognising that outcomes are only one segment/moment in time on the continuum of learning as children build their understanding of their world. It is not a means to an end! We believe the curriculum that is academically instructive and prescribed yields less learning. Lilian Katz reflects our beliefs in her statement, ‘teaching methods are likely to be best when they address children’s lively minds so that they are quite frequently fully intellectually engaged.’

What is our evolving understanding of this child and their learning? What key understandings, dispositions and learning processes is this child developing?
As a provocation I brought in a collection of small dinosaur models for the children to explore. It created a buzz of excitement in our room. They began to transport them into the middle of the room, arranging them in size and order. I sat next to them and quietly observed in an unobtrusive way as they manipulated the models, I listened to their conversations.

“Look at these spikes on its back”

“They’re really sharp”

Another child picked up another one and said, “This one is bigger. Look, it’s got a tail…”

I looked over at the dinosaurs and made slow deliberate movements to model my curiosity about its features

“I wonder why do dinosaurs have spikes on their backs… I notice some don’t have any.”

When facilitating discussions and participating in discussions with young children, I try to continually remind myself not to jump in with an answer or give a solution to a problem. I try to stop and think for a second before I respond to a child’s statement, comment, or question in a way that will extend their thought and encourage more discussions. It is a constant learning experience.
As Harlan and Rivkin point out (2012, pp.34-5), open-ended questioning can serve many purposes, including:

- **Instigating discovery**
  an activity becomes a discovery challenge when it is initiated as a question to answer

- **Eliciting predictions**
  it can be helpful to encourage children’s predictions before they investigate an idea;

- **Probing for understanding**
  careful questioning helps to uncover children’s conceptual understandings;

- **Promoting reasoning**
  careful questioning can help to elicit children’s thought processes and encourage them to explain and justify their ideas;

- **Serving as a catalyst**
  sometimes a question can be a catalyst that sparks interest in an investigation;

- **Encourage creative thinking and reflection**
  questioning can help children to think about their learning and make connections to other experiences;

- **Reflecting on feelings**
  questions can be used to identify particular concepts or experiences that capture children’s interest.

As our conversations flowed, I was able to draw out children’s thoughts, ideas and questions so that we could plan experiences that would help us find out more. With older four - five year olds, questions often come quickly and naturally, but with the younger children, it often results in telling of a story or narrative.

I tune into child’s interest and frame some of the children’s thoughts into questions.

“**Is that something you would like to know about?”**
“**Would you like to know how to use that?”**
“**I am wondering about...? What do you think?”**

My priority is for children’s learning to include amazement, joy, magic and wonder. To follow on for the exploration of the dinosaurs I brought in a hatching dinosaur egg and a fossilised egg from the shop. There was much anticipation and awe to which baby dinosaur might hatch, and to see what would happen if we add water. We watched and waited, predicted, hypothesised and questioned.

This exploration paved our learning about palaeontologists and fossils. The children conceptualised fossils as bones, but there were still gaps of knowledge opportunities for future learning. We investigated ways to create our own dinosaur fossil and started to learn all about palaeontology and what a palaeontologist does. I posed the question of what Pete the Palaeontologist might need to dig up fossils. This became another investigation and thread to explore.
Learning environments were designed to support children’s autonomous research and included resources such as fiction and non-fiction books, artefacts, materials and props for role-playing, connecting to our topic of inquiry. As the children engaged in our environment, they represented and consolidated their understandings, by exchanging views related to the topic. Sharing and discussing these early explorations related to our topic, helped children to build a shared perspective.
As the exploration grew to new concepts I continued to use the strategy of questioning. As the children were building volcanic mountains in the sandpit, I discovered that the children already knew quite a lot about volcanoes. Through the discussions the children presented theories. In order to test their theory, I gave them the autonomy of conducting their own volcano experiment and asked them some questions during the experiment.

“How can you make this volcano erupt?”
“What can you hear when the volcano is erupting?”
“I wonder what happens when you add another spoonful of vinegar?”
“What makes the volcano erupting forever?”

Our play environment catered for all different kinds of learning and I was able to watch and observe the children’s use of language, and their interaction patterns, play and dispositions. Through these observations, we noticed a group of children, building a dinosaur land out of blocks. Everyday, they worked on it for lengthy periods of time and wanted everyone to come and see. After having a discussion with our children about what we can do to get everyone to see our work in our room, I presented them an idea with a question...

“What if our whole room turned into a dinosaur museum and we can invite other children and parents to come and see?”

This became our driving question, or a catalyst for an authentic learning experience to engage, motivate and help children find a purpose for their learning for the next two months.

Referring to our driving question we asked questions related to their plan, design, theories and model. We brainstormed, areas that our museum would need. They discussed what they felt others needed to know about dinosaurs, what the dinosaur’s habitat looked like including volcanoes, an area for visitors to be palaeontologists and a skeleton of our favourite dinosaur- Tyrannosaurus Rex. This became an ongoing and very involved project. The disposition to observe and to formulate questions, strengthen the investigation of the children’s interest and experience. Sharing these questions that children have generated helped parents to see the level of expertise needed in the project.
When I see the higher-level thinking that my children are doing, it raises my expectations for them. I ponder more deeply as to how to support their learning and I have a greater passion for how children learn.

Questioning is a habit and skill for inquiry. When children ask the real questions, that is, questions that stem from their desire to understand the world around them and making connections, learning feels meaningful. There is no right or wrong answers and a child’s thinking may lead the project in a different direction altogether.

What is your driving question? Is there a question that you can pose, to explore the answers where they feel motivated to exercise their sense of agency and build their independence skills.

References

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Where children come first