

STEM Education: what about VET qualified early childhood educators?

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Abstract

There is a critical shortage of students studying Science Technology Engineering and Mathematics (STEM) courses at Universities across Australia. Over 75% of jobs now require STEM skills (Chubb et al, 2012). The Australian government spends millions of dollars in improving STEM teaching and outreach programs for secondary and primary schools, however there is little targeted support for early childhood educators, especially those enrolled in Vocational Education and Training qualifications. This paper draws on ideas from the Science Education Experience to suggest strategies for a collaborative approach to science education professional development for early childhood educators working in the birth to 5 sector (that is, in early learning centres and preschools/kindergartens). The Science Education Experience was conducted in regional Queensland for primary pre-service and in-service teachers utilising local experts and hands-on activities to allow educators to increase their knowledge and expose them to local resources in order to improve their teaching. This paper explores how a collaborative learning event such as this one could be modified and contextualised for early learning centres to align with the Early Years Learning Framework, intentional teaching, play based learning and relevant modules in the Diploma of Early Childhood Education and Care (CHC50113) to support educators to build the STEM skills needed to improve young children's early science understandings and longer term learning outcomes around STEM.

Introduction

There is a growing need to enhance STEM (science, technology, engineering and mathematics) education in Australia. With increasing advances in technology occurring world-wide, there is a need for an increasingly skilled workforce (Tytler, 2007). Since teachers are the most valuable resource available to both schools and higher education institutions in achieving global competitiveness, an investment in teacher quality and ongoing professionalism is vital (Prasser & Tracey, 2013).

Recognising the need for professional development in science education, the *Science Education Experience* two day professional development event was planned and conducted for pre-service and in-service teachers and community educators. The event was developed by a University Academic and a Project Officer from a not-for-profit partner with funding from an industry community grant. It brought together local community groups, industry and educators. Participants were immersed in real-world

science applications and were provided with first-hand experiences of how science is being enacted in everyday life.

Teachers need to be able to contextualise the science concepts being taught in the classroom and this unique professional development opportunity has provided educators with the opportunity to network and engage with science while also utilising technology, drama, industry tours, laboratory work and a trip to Quoin Island. Incorporating a wide range of curriculum areas was used to emphasise the integration of science (Venville et al, 2002) across the curriculum. The *Science Education Experience* event provided a possible solution to improving STEM education by bringing together communities, government and educators to provide support through a “lived experience” in the way science is being practiced.

At an early age all children have the capacity to observe, explore and discover the world around them (NRC, 2012). These are basic abilities for science learning that can and should be encouraged and supported among children in the earliest years of their lives (NSTA, 2014). The starting point for learning in science is observation, which leads on to sharing of ideas, experimentation and inquiry. “Learning science begins with babies looking around, gradually acquiring manipulative skills they can use for a definite action and then play.” (Tunnicliffe, 2015, p. 3). The early years provide a foundation for learning science in the school years.

Background

In May 2012, the Chief Scientist at the time, Professor Ian Chubb AC, released the report *Mathematics, Engineering, and Science in the National Interest*. The report recognised that over the past 20 years, Australia has experienced a decline in the proportion of students taking advanced STEM subjects in year 12 and a downward trend in the proportion of university students enrolled in maths, science and engineering courses (Chubb et al, 2012).

The Australian Maths and Science Partnership Program (AMSPP) was announced in the Federal Government’s 2012 Budget as part of a broad package of measures to address this trend. The Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education (DIISRTE) announced funding for grants to help improve student’s engagement in maths and science courses, through partnership between universities, schools and other relevant organisations.

As part of this Australian government initiative, five collaborative projects were funded with an aim to build the confidence, capacity, knowledge base and teaching skills of classroom teachers to deliver maths and science subjects to primary and junior secondary school students. All of these projects are aiming to harness science experts’ skills, knowledge and understandings by bringing together science experts with educators in a collaborative approach to improve the teaching of pre-service teachers. While some of these projects have a focus on primary education none of the projects involve the early childhood sector. The exclusion of funding for improving the science components for early childhood educators while undertaking training including the CHC50013 course Diploma in Early Childhood Education and Care indicates an apparent lack of importance placed on the early childhood sector by the Australian

government. The early childhood sector needs to be included in funding to improve STEM education.

The Advancing Education Agenda is an action plan for education in Queensland. The reforms to education over the past few years have provided greater access to kindergarten, a full-time Prep year, and the process of transitioning Year 7 into high school. The latest Advancing Education Agenda for 2016 has an area titled *A skilled and capable workforce* in which the action plan states “We will improve the quality of early childhood services by implementing a contemporary early childhood Workforce Action Plan to lift capacity and capability” (Department of Education and Training, 2015, p. 8). Under *Investing in schools*, the action plan states a priority focus on STEM. Those strategies specifically relevant to the early childhood sector include improving *teacher readiness* in STEM and also promoting active partnerships with business, industry and universities.

In addition to the Queensland State Government’s Advancing Education Agenda, the Federal Government recently announced the National Innovation and Science Agenda (NISA) which aims to *inspire all Australians—from preschoolers to the broader community—to engage with STEM in society*. There are four key pillars:

1. Culture and capital,
2. Collaboration,
3. Talent and skills,
4. Government as an exemplar.

Under the *talent and skills* pillar, there will be funding for professional development for teachers and specialised programs to bring STEM experts into classrooms. Almost \$65 million has been allocated for ten initiatives under the *Inspiring all Australians in Digital Literacy and STEM* measure as part of this Federal Agenda. The aim of these ten initiatives is to increase the participation of Australian children and young people in Science Technology Engineering Mathematics (STEM) and improve their digital literacy. This Agenda includes opportunities *for children to participate and engage in early childhood, primary and secondary school settings* (Australian Government, 2015).

Under the NISA Agenda, STEM engagement in the early years comprises of three initiatives. Firstly, \$4 million to expand the Little Scientists program which aims at engaging young children in fun experiments and other activities, a further \$4 million to expand and improve the existing program, Let’s Count, which is designed to engage parents and their children in the early concepts of mathematics, and finally \$6 million to develop and disseminate a series of play based apps called Early Learning STEM Australia (ELSA). These apps will foster an interest and appreciation for science and mathematics among young children and their carers (Australian Government, 2015).

The *Science Education Experience* event was developed based on research indicating that teachers are lacking confidence to teach science (Bursal & Paznokas, 2006; Kidman, 2012). Educators from around Queensland came to CQUniversity Gladstone Marina Campus in August 2015 for a hands-on weekend to help them bring science to life. The CQUniversity *Science Education Experience* event was held in National Science Week. It was a professional development event presenting a unique opportunity for capacity building and was organised by CQUniversity and Fitzroy Basin Association through funding from the Australian Government’s National Landcare Programme and Queensland Gas Company (QGC) community grant.

There were rotational activities over two days with the second day being held at Quoin Island. The activities included water quality testing in the laboratory, a guided industry bus tour, a Botanic Gardens visit, and a networking event with guest speaker Ranger Stacy Thomson from Totally Wild. The two-day experience also included participation in a “Mangrove Drama” performance to provide dramatic inspiration, a boat trip and tour of Quoin Island’s Turtle Rehabilitation Centre, a Catchment Story interactive presentation, bio-condition monitoring of the mangrove landscape, a marine debris clean-up and analysis of data collected and also a presentation by Reef Guardians. The interactive sessions included links to the Australian Curriculum. This could be modified to provide links to the Early Years Learning Framework (EYLF) for early childhood educators and also to the modules in the CHC50113 (Diploma of Early Childhood Education and Care) curriculum for educators who are working in early childhood centres and kindergarten/preschools and enrolled in a distance education mode. The EYLF and the quality assurance focus in early childhood centres highlights the importance of sustainability that can also be interpreted as being around environmental science.

The Early Years Learning Framework includes Vision and Principles as well as Practices. The vision and principles set the stage for educators’ programing decisions and children’s learning. These are divided into three main areas - belonging, being and becoming. Under ‘being’, children are to seek and make meaning of the world (Department of Education, Employment and Workplace Relations, 2009). Early childhood educators provide opportunities for children to develop socially, emotionally, physically and cognitively. There is a balance between intentional teaching and play based learning which allows a holistic approach to learning.

Intentional teaching involves guidance from the educator in the form of questioning and providing resources.

“Intentional teaching is deliberate, purposeful and thoughtful. Educators who engage in intentional teaching recognise that learning occurs in social contexts and that interactions and conversations are vitally important for learning. They actively promote children’s learning through worthwhile and challenging experiences and interactions that foster high-level thinking skills. They use strategies such as modelling and demonstrating, open questioning, speculating, explaining, engaging in shared thinking and problem solving to extend children’s thinking and learning.” (DEEWR, 2009, p.15)

Kilderry (2015) sites Epstein who maintains that intentional teaching is "not happening by chance ... it is through planful, thoughtful and purposeful actions and it is teachers recognising opportunities for the child to learn". Intentional teaching includes more than imparting skills and knowledge to children. Intentional teaching involves decision making, intentionally planning and also creating supportive learning environments (Kilderry, 2015).

To create learning environments conducive to STEM skill development for children there needs to be the appropriate skill development and understandings of the scientific process for educators. The three initiatives under the Federal Agenda for early childhood involve educators providing engaging experiments, mathematics activities and using apps. Early childhood educators need to have access to support in developing their

understandings of these STEM areas either with Professional Development experiences or by collaborating with experts in these areas.

Learning through play provides opportunities for children to learn as they discover, create, improvise and imagine. Play provides a supportive environment where children can ask questions, solve problems and engage in critical thinking.

Early childhood educators engage in shared conversations with children to extend their thinking and they create learning environments that encourage children to explore, solve problems, create and construct (DEEWR, 2009, p. 15).

The educator can move in and out of intentional teaching and being responsive to the children especially when fostering critical thinking. Problem-based learning is embedded in all content areas of the EYLF and educators need to have adequate problem solving skills themselves in order to be able to guide the children to become confident and involved learners. As can be seen in Figure 1, the EYLF specifies that children develop a range of skills including inquiry, experimentation and investigating. The educator needs to be confident in these science skills in order to be effective in facilitating both play based learning and intentional teaching.

OUTCOME 4: CHILDREN ARE CONFIDENT AND INVOLVED LEARNERS

Children develop a range of skills and processes such as problem solving, inquiry, experimentation, hypothesising, researching and investigating

This is evident, for example, when children:

- apply a wide variety of thinking strategies to engage with situations and solve problems, and adapt these strategies to new situations
- create and use representation to organise, record and communicate mathematical ideas and concepts
- make predictions and generalisations about their daily activities, aspects of the natural world and environments, using patterns they generate or identify and communicate these using mathematical language and symbols
- explore their environment
- manipulate objects and experiment with cause and effect, trial and error, and motion
- contribute constructively to mathematical discussions and arguments
- use reflective thinking to consider why things happen and what can be learnt from these experiences

Educators promote this learning, for example, when they:

- plan learning environments with appropriate levels of challenge where children are encouraged to explore, experiment and take appropriate risks in their learning
- recognise mathematical understandings that children bring to learning and build on these in ways that are relevant to each child
- provide babies and toddlers with resources that offer challenge, intrigue and surprise, support their investigations and share their enjoyment
- provide experiences that encourage children to investigate and solve problems
- encourage children to use language to describe and explain their ideas
- provide opportunities for involvement in experiences that support the investigation of ideas, complex concepts and thinking, reasoning and hypothesising
- encourage children to make their ideas and theories visible to others
- model mathematical and scientific language and language associated with the arts
- join in children's play and model reasoning, predicting and reflecting processes and language
- intentionally scaffold children's understandings
- listen carefully to children's attempts to hypothesise and expand on their thinking through conversation and questioning

Figure 1: Science Skills.
Source: EYLF (DEEWR, 2009).

The pedagogical suggestions in the EYLF promotes both play based learning and intentional teaching. Educators need to have the confidence and competence to effectively foster natural play and inquiry. Educators need to be prepared in order to create challenging learning environments for the children and as such there needs to be an increase in STEM support for early childhood educators.

Across Australia, most early childhood educators who are undertaking VET qualifications such as the Certificate III or the Diploma in Early Childhood Education and Care are enrolled externally and are already employed in an early learning centre or kindergarten/preschool. At CQUniversity Gladstone alone close to 200 of the 220 students enrolled in these courses are working in the industry. Not surprisingly, these employees have limited opportunities to interact with local STEM experts as they are, typically, working full-time and replacing a staff member who is undertaking professional development is sometimes difficult in regional areas. It is more difficult for these employees to access opportunities such as the *Science Education Experience*, although this was conducted over a weekend.

Within the Diploma in Early Childhood Education and Care (CHC50113) the unit CHCECE017 *foster the holistic development of the child in early childhood* covers the basic concepts such as teaching about grouping, colours and shape. There could be opportunity within this unit to further develop the STEM skills of the educator by giving them a task which involves finding and interviewing a local expert to increase their own STEM knowledge and understanding.

In early childhood education learning is primarily guided by the child's interest within the broad framework of outcomes indicated in the EYLF. Educators need to be empowered with the appropriate language tools to foster natural play and inquiry confidently. For this reason, a centre located in Gladstone for example, has a pet turtle since most children will see turtles swimming in the oceans and creeks on the weekends. Educators at this Gladstone centre therefore would benefit from developing a knowledge base about the types of turtles in the area and their habitats. Developing this type of environmental awareness can be facilitated by an event such as the *Science Education Experience* in that it brings local experts to the centre either to upskill the educators and/or as a resource to enrich children's learning (intentional teaching). Local and regional concepts can be applied when the educator has sufficient knowledge and understanding and skills to facilitate the learning. For example, photos or videos (e.g. on YouTube) of turtles hatching during season can be used as a stimulus to promote local understandings. A map of Gladstone could be used which may lead to discussions on marine debris, sustainability, indigenisation and so on. Educators may have increased confidence to foster the inquiry and questions from children when they have been informed by local Elders and scientists or community organisations.

Since science is a part of everyday life, local contexts can be applied to any centre. The example above uses turtles for Gladstone but since many centres have outdoor areas there is a possibility to include plants, developing vegetable gardens, pets such as fish or chickens, worm farms, solar powered "toys", fountains, sand pits, wheels and so on as contexts. The scientific concepts involved range from simple to complex and include physics within playground equipment and water, wheels and sand pit toys. In order to foster creative thinking and challenge children while they explore and learn about the world around them, early childhood educators need to be supported to think creatively

and explore the local contexts available in their region with the resources available at local centres.

The use of local and regional experts can enhance the science understanding for educators (Lyons et al, 2006). The benefits of collaborative approaches such as networking and professional development within early childhood settings have been documented (Howitt, 2010). Practical opportunities for early childhood educators who are studying early childhood education and care qualifications through VET pathways to collaborate with local experts in an organised event such as the *Science Education Experience* would provide valuable, enriching experiences to bring science to life - opportunities that most do not receive since they are studying by distance and working full time.

In summary, the *Science Education Experience* event brought pre-service and in-service educators to the “real world” science in collaboration with local experts. Local STEM experts such as conservationists, vets, researchers, engineers and digital media experts should be included in the activities or assessments as part of the CHC50113 diploma as a way of improving the STEM skills of the educators and also increasing their network opportunities locally.

This “enhancement” in the form of professional development for educators studying and working in the sector could bring new knowledge and understanding as well as local guest experts into the centre for the rest of the staff and children to benefit from. The National Science Teachers Association (NSTA) in the United States recommends early childhood educators be provided with “professional development experiences that engage them in learning science principles in an interactive, hands-on approach, enabling them to teach science principles appropriately and knowledgeably” (NSTA, 2014, p. 4).

Research Question

The *Science Education Experience* that was conducted in Gladstone in August 2015 included survey data collection to determine whether local educators were aware of local science experts available for use in planning. If this event was to be repeated or embedded as a STEM project for students enrolled in the Diploma in Early Childhood Education and Care, data could be collected to see whether educators found the collaboration and “enhancement” useful and whether there was any follow-up activity in the form of increased guidance for the children, intentional teaching in the particular STEM area of the project or expert visits to the centre or kindergarten/preschool.

Findings and discussion from the Science Education Experience event

The *Science Education Experience* involved 48 participants. Of those who completed the surveys (n=47), there were 39 females and 8 males. The 47 participants included 35 teachers, 10 pre-service teachers and 2 others (such as a guide leader).

The 10 pre-service teachers included 6 primary, 1 secondary and 3 early childhood students. The 35 teachers included 12 from a 7-12 school, 9 from a P-6 school and 14 others. The 14 others included 1 from a kindergarten and 3 from a special education context.

Table 1: Reasons for attending (top 5) Respondents could choose more than one response

Response	Count (n=44)	Percent
Gain ideas for teaching	36	82
Increase science content knowledge	29	66
Environmental knowledge	27	61
Visit Quoin Island	27	61
Network with other educators	20	46

This was a weekend event with 15 hours credited towards professional development for teacher registration yet only 32% (n=14) selected *Increase PD (professional development) hours* as a reason for attending. *Increase local contacts* was higher than *Increase PD (professional development) hours* at 34% (n=15) indicating the importance that participants place on increasing local contacts.

Table 2: Changes pre and post to understanding of local resources available

Pre		Post	
I have a good understanding of the types of local resources available to assist me with planning	2.86	I have a better understanding of the types of local resources available to assist me with planning	4.39

There was a significant change in responses of participants to the understanding of the types of local resources available to educators. This indicates that the educators who attended the event were not aware of local science experts available for use in planning. There is a vast array of local organisations that have developed resources for early childhood, primary and secondary students that educators can use in their planning. The *Science Education Experience* event brought together some of these underutilised resources as a small step to improve the understanding for educators of the benefits of collaborating with experts which provides great opportunities to learn as well as saving time in planning.

Conclusion

The *Science Education Experience* was a successful event. The presenters of this particular event could be utilised to run a similar event in Gladstone specifically for early childhood educators. The Rio Tinto Here for Childcare funded initiative could be one avenue for funding an early childhood science event and providing access to local environmental experts for early childhood educators. While the *Science Education Experience* event had an environmental science and chemistry theme, future events that would be useful to the early childhood sector could include digital media training in preparation for the government’s development of the series of play based apps (ELSA).

In terms of the VET sector, embedding a STEM project into one of the units within the CHC50013 Diploma would provide a valuable opportunity for early childhood educators who are studying the VET pathway and working full time to experience science ‘first hand’ and interact and collaborate with experts.

The government priorities within the STEM space including for early childhood cannot be ignored and need to be embraced. At CQUniversity we have a unique opportunity to embed a STEM Project within our Certificate III and Diploma programs since we have science, technology, engineering and mathematics experts and educators within our University who could be utilised in the development of a STEM enrichment Project but who could also be utilised as visitors to our students within their workplaces (centres and kindergartens/preschools). The option of a STEM Project embedded in the courses identifies a potential real solution to improving the future of STEM education within the early childhood VET sector.

Investments by the Australian government in STEM education need to include the early childhood sector. Early childhood provides the foundation for learning. Early childhood educators need support to improve STEM skills. There needs to be a collaborative approach between STEM specialists, local organisations, industry, universities, government and the community to incorporate professional development events like the Science Education Experience into local regions and into the Education VET Courses.

Although this final quote is from the Queensland Government, it certainly applies to Australia as a whole:

Partnering with universities, business and industry is important to make sure our teachers and students are connected to cutting edge developments. Strengthening these relationships will see students engaged with the rich world of the STEM community and inspired to be the creators of Queensland's future (Department of Education and Training, 2015 p.9)

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