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STEM EARLY YEARS

STEM Play: STEM in the Early Years
Growing a generation of STEM capable learners

STEM LEARNING

'STEM education in the early years provides a context for designing active learning environments that connect with children's natural curiosity about their world. It engages children in authentic investigations, using critical and creative thinking in systematic ways to build knowledge, acquire skills and cultivate confident dispositions for STEM learning.' (Yelland, 2019)

THE **WHY** OF STEM

Innovative futures begin today

The Department for Education's STEM Learning strategy (DECD, 2016) emphasises the growing importance of STEM in contemporary societies and economies.

The broad skills fostered by STEM learning will be needed in the future to solve emerging problems and respond to challenges with entrepreneurial thinking.

Modern education systems encourage children to become confident and competent learners who use interdisciplinary STEM knowledge and skills, along with dispositions for learning such as curiosity and creativity, to generate innovative ideas, identify problems and explore solutions.

THE **WHAT** OF STEM

Playing with ideas and explorations

Children are the original scientific researchers. Research is, from birth, how our youngest citizens approach the world. In play children research their world, using both their bodies and minds. They are curious, agile explorers who examine carefully and closely the things they encounter. They devise hypotheses, develop and test often and rethink their ideas, based on further observations and input from others. It is through this inherent process that children grow their skills and knowledge of science, technology, engineering and mathematics. (Katz, 2010)

The ways in which children experience their learning matters. STEM teaching and learning has the potential to create strong foundations for lifelong learning. The STEM environment must serve as an invitation to enter, participate and explore what children know, question and imagine. Early years STEM learning is as much about place and purpose, as it is about resources and materials. (Rosicka, 2016)

When supported, children are playful, confident, critical and creative participants who will engage with learning that matters to them, their families and communities. Consequently, educators should position themselves as a collaborative partner - alongside the child, reflecting the child's ideas, acknowledging what they already know and bridging to what they are on the edge of understanding. From this position educators are well placed to expand on children's STEM thinking, knowledge and skills. (Siekmann, 2016; Sanders, 2012)

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STEM rich environments are those that enable collaborative learning and work most effectively when they provide open questions for children to explore. Educators plan learning experiences that support social development, such as group project work, as an intrinsic builder of cognitive development. These learning environments are what is termed, a learning ecology, (Bronfenbrenner & Morris, 2006), where experiences are planned with children, from their ideas, to enable incidental, spontaneous and necessary dialogue, observations, imagining, challenges, mistakes and critical reflection. (Yelland, 2018)

THE **HOW** OF STEM

Promoting STEM inquiries and pedagogies

STEM learning in the early years should be viewed as a teaching approach where process guides children, and educators, to develop skills and knowledge through collaborative learning experiences. The starting point of this approach should be the children's own wonderings and explorations. (Marginson et al 2013; Sanders 2012; Vasquez, 2014)

Consistent with STEM learning being hands on, lived experience, the following teaching and learning strategies are particularly useful:

- **Project-based learning** (Katz & Chard, 2000) centred around a specific question or problem that has been suggested by the children. This will:
  - Be undertaken for an extended period of time.
  - Engage with authentic, real-world issues. (Sanders, 2012; Vasquez, 2014)
  - Support children to view a problem and its possible solutions through an ethical lens and in the context of a larger system. (Kelley & Knowles, 2016)

- **Inquiry-driven learning**
  - Based on the children's own perspectives, ideas or questions and their investigations; creativity is inherent in this approach. (Marginson et al, 2013; Sanders, 2012; Vasquez, 2014)
- **Problem-based learning**
  - Centred on open-ended propositions.
  - Designed to challenge current thinking, consider other perspectives and find alternative solutions.
  - Connected to the children's natural desire to solve real problems.

A play-based approach is central to this process, enabling children to design and test a solution multiple times, and in multiple ways, supporting their ability to make generalisations as well as critical and creative thinking. (Kelley & Knowles, 2016)

Active and involved educators in the STEM learning enviroment must:

- ensure children share their documentation and thinking with a group of learners, as an opportunity to consider other children's ideas and perspectives
- be alert to the many ways children document their research—eg images, graphics, moving images, etc—(this work can then become a catalyst for ongoing learning)
- engage in consistent, collaborative critical reflection and documentation of the productive play of the children

- engage in dialogue with children, connecting actions taken with their impacts on others as they formulate ethical STEM solutions
- support children to view their world as part of a bigger system with a need for sustainability, drawing their attention to how the planet is a system and what we do matters and can effect the health of the planet
- encourage children to reflect on their documentation and re-evaluate their earlier thinking and ideas, so that they view problem solving as an iterative process that leads to bigger and better questions.

THE **WHEN** OF STEM

Designing learning that will grow a generation of new learners

A focus on STEM learning does not mean early childhood educators do more, but it might mean doing differently. It also does not mean a certain time, or space, needs to be set aside for STEM; as children are natural researchers in their play, the opportunities for STEM learning are everywhere. The role of the educator is to notice the opportunities for teaching and learning as they arise and to recognise what the children are actually interested in exploring.

When designing STEM learning educators must be purposeful in their approach. Importantly, they must be aware of how much space and time they need to allow children for original thinking and resist the need to restrict children's ideas with predetermined notions of what is correct.

Guiding children to represent, discuss and share their thinking in a variety of ways, including graphics, image making, sculpture and song, will support meaning making and builds a shared understanding of the many ways we can view subjects and/or solve a problem. This exchange of ideas is valuable to all learning, as new ideas are generated through supported listening and argumentation. The process of documentation also enables educators to get closer to the focus of children's interests, intentions and ideas as they reflect on the question 'What is it that they *really* want to explore further?' This work then becomes the catalyst for the learning design.

Sharing the documentation of learning, by the educators and children, makes the thinking visible to children, other educators, families and the community. Revisiting the documentation promotes reflective thinking in children, actively engaging them in the design and evaluation of their own learning.

References

Bronfenbrenner U & Morris PA (2006) 'The bioecological model of human development', *Handbook of Child Psychology*, Volume 1, Theoretical Models of Human Development, John Wiley & Sons

Department for Education and Child Development (DECD) (2016) *STEM Learning strategy for DECD preschool to year 12 2017–2020*, Government of South Australia, Adelaide: Australia

Katz LG (2010) 'STEM in the Early Years', paper delivered at the SEED (STEM in Early Education and Development) Conference, University of Illinois at Urbana-Champaign, retrieved May 2019 at http://ecrp.uiuc.edu/beyond/seed/katz.html

Katz LG & Chard SC (2000) *Engaging children's minds: The project approach*, 2nd ed, Stamford, CT: Ablex

Kelley TR & Knowles JG (2016) 'A conceptual framework for integrated STEM education', *International Journal of STEM Education*, 3:11, retrieved May 2019 at https://link.springer.com/content/pdf/10.1186%2Fs40594-016-0046-z.pdf

Marginson S, Tytler R, Freeman B & Roberts K (2013) *STEM: Country Comparisons – International comparisons of science, technology, engineering and mathematics (STEM) education*, Australian Council of Learned Academies (ACOLA), Melbourne: Australia

Rosicka C (2016) *From concept to classroom: Translating STEM education research into practice*, ACER, Victoria, Australia

Sanders M (2012) 'Integrative STEM education as best practice', in H Middleton (Ed.), *Explorations of Best Practice in Technology, Design, & Engineering Education*, Vol 2, 103–117, Griffith Institute for Educational Research, Queensland: Australia

Siekmann G (2016) *What is STEM? The need for unpacking its definitions and applications*, National Centre for Vocational Education Research (NCVER), retrieved May 2019 at https://www.ncver.edu.au/__data/assets/pdf_file/0023/61349/What-is-STEM.pdf

Vasquez J (2014) 'STEM: beyond the acronym', *Educational Leadership*, Dec/Jan 72:4, pp.10–15, ASCD

Yelland NJ (2018) A pedagogy of multiliteracies: Young children and multimodal learning with tablets, *British Journal of Educational Technology*, 49(5), 847–858, Wiley

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This paper is part of the STEM Quest professional learning for early years educators.

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