How children learn: Principles to underpin curriculum design

ECE resources

Research suggests that many teaching strategies, such as direct instruction, child-initiated play, structured activities, and engagement with older peers are effective for supporting children's development, but none are appropriate or sufficient for all learning goals. For example, social competence is more likely to develop during play than direct instruction, but direct instruction might be more effective for building academic knowledge, such as phonemic awareness and number knowledge. It is important to use multiple teaching strategies flexibly, adapting them to meet individual children's specific needs, prior knowledge, and current level of understanding in relation to desired curriculum goals.

Research within the disciplines of neuroscience and cognitive psychology offers seven broad principles to support optimal learning and brain development in the early years. These are:

1. Emphasise relationships and responsive interactions
2. Nurture children's wellbeing
3. Build on prior learning
4. Use authentic and meaningful contexts
5. Mediate and support learning through intentional interactions
6. Allow for experimentation, consolidation, and practice
7. Develop children's capacities for learning to learn

Emphasise relationships and responsive interactions

Social interactions are extremely significant in children's learning in all areas. Children are social learners whose development occurs in the context of their interactions with other people and with their environment. Through meaningful interactions with caregivers that involve increasingly complex problem-solving and communication, children learn to think and to use language and other symbols to express experiences and ideas. Children's ability to make the most of learning opportunities in an early childhood setting are dependent to a great extent on their ability to trust and establish a secure bond with the teacher, as well as to negotiate successful relationships with peers.

Neuroscience demonstrates that from infancy, children's brains are specially focused on receiving and understanding stimulation from other people: they are born with brains primed to recognise faces and to understand other people as a key source of their learning (children's neurons fire more strongly when something is presented as important to adults, or in situations where they perceive that adults are trying to teach them something). Nurturing interactions with adults provide sensory stimuli that develop the neural pathways foundational to many of the brain's core competencies, including language, cognition, and coping strategies.

The most important pedagogical principle for effective early learning is responsiveness. Teachers' responsiveness to children's developmental levels and characteristics is crucial to supporting their learning and development, and has a significant effect on the way that neural connections are wired. Joint attention and joint action with others are important for strengthening a sense of connection with another

person – seeing the same things, doing the same things, and sharing the same feelings about those things. Long-standing relationships between teachers and children enable the development of a shared common background of experiences to draw on in ongoing interactions, thereby promoting more effective interactions. Quality relationships that are highly nurturing and interactions that are highly responsive are the greatest factor in increasing learning and development, supporting better outcomes in terms of children's peer relations, behaviour, dispositions for learning, and later school achievement.

In high quality, responsive interactions, teachers are genuinely interested in the child's thoughts and actions: they listen, extend children's thoughts and knowledge, and co-construct meanings together through the process of knowledge-sharing and exchange in order to develop 'sustained shared thinking' and intersubjectivity (a shared focus, understanding, and purpose). Children or teachers can initiate interactions, but it is the response given that ensures a turn-by-turn conversational flow, and a smooth flow of sequence of actions and words jointly constructed by the teacher and child. Rich, two-sided and sustained conversations are related to healthy language development and later academic success.

When implementing responsive interactions, it is important to:

- **Ensure both teachers and children have plenty of time for interaction**. Join in and play, and get down to a face-to-face level with children.
- **Demonstrate an emotionally warm, devoted, and appreciating stance** towards children in order for strong emotional bonds, positive feelings, and motivation for learning to develop. Use touch to communicate care and provide children with a sense of security, confidence, and self-assurance as well as sensory stimulation.
- **Make overtures to children through comments that are in tune with their current focus of attention** to foster reciprocity and intersubjectivity, then build on the children's activities, taking into account their interests, prior knowledge, and skill level, to create back-and-forth dialogue (also known as serve and return). Notice where infants look and what they touch to find out their interests, and engage with them on those things. A shared focus or intersubjectivity can be achieved through language, touch, physical actions, or engaging with the emotions of an interaction.
- **Intently listen to children**, allowing children to initiate conversations. Select an aspect of a child's utterance to build upon by asking questions or providing further information. Promote reciprocity and children's active participation in exchanges by being responsive emotionally (maintaining eye contact, smiling) and linguistically (consistently responding to children's communications, recasting or expanding children's comments), and being interactive (slowing down, giving cues for the child to take another turn, and asking open-ended questions). This promotes children's sense of competence and self-determination.
- **Observe children's social interactions**, and work to facilitate positive peer relationships. For example, invite children to join the conversation, refer children to one another for information or help, and invite children to interact together. These strategies have been found to increase the number of utterances children direct at their peers during play. Furthermore, positive relationships with peers are significant for children's social and emotional development.

Nurture children's wellbeing

Emotions are highly significant in the functioning of the brain, and emotional processes affect all other neural processes. Fear and stress are found to reduce analytical capacity, whereas positive emotions open pathways within the brain. For older children, cognitive learning is greatly enhanced when children experience feelings of confidence, emotional devotion to a topic, and being carried away by a topic.

Emotional security enables the self-regulation required for more effective engagement with learning opportunities. Positive and pro-social environments in which children experience close relationships with teachers, well-developed play scenarios with peers, and minimal disruptive behaviour are important for children's sense of wellbeing. Research also finds that the quality of care in early childhood settings makes a difference to children's cortisol levels and stress: high-quality early childhood settings are associated with children's lower cortisol levels at the end of the day.

Finally, neuroscience suggests the essential role of restorative sleep for learning as well as wellbeing (which might explain why our youngest learners, who are building the greatest number of neurons and synapses, require much more sleep than we as adults do!). During sleep, brain scans suggest that brains retrace the neuronal firing patterns of the day's experiences, at a much faster speed, as if condensing them into memory. Nurturing and relaxed routines for sleep are also crucial for children's wellbeing and learning.

When implementing strategies for nurturing wellbeing, it is important to:

- **Attend to children's needs for good nutrition, sleep, and physical exercise**, which are conducive to improved brain functioning. Ensure children have quality naps. Naps support children's learning by consolidating memories acquired earlier in the day.
- **Provide environments in which children feel safe and supported** by adults who can manage the cognitive, physical, and emotional challenges that children experience. This means attending to adults' wellbeing too! Enjoy children's adventures with them, and experience lots of genuine delight in the child. Develop trust through the provision of clear expectations and directions as well as positive consequences for appropriate behaviour.
- **Help children to organise their feelings** by acknowledging and accepting their feelings rather than seeking to change them, for example, 'I can see that you feel sad at the moment, you feel sad when mummy has to go'. Empathise with an infant or child using tone of voice, gesture, and facial expression, and then slowly adjust to a calmer state. This is called co-regulation.
- **Ensure that children experience the positive emotions associated with learning and gaining skills and understanding**. Research finds that the brain responds very well to the sense of illumination and enlightenment that comes with grasping new concepts, especially if there is initially some puzzlement or unexpectedness about a situation or event. Plan for challenging activity that is just beyond, yet within reach of, children's current skills and understanding, and don't be afraid to introduce new concepts and skills.

Build on prior learning

Many cognitive science researchers now think of young children as scientific in their approach to learning about the world. Some suggest that infants are actually born with a set of assumptions about how the world works and then use all their senses to collect data to prove or improve them. This means *Te Whāriki*'s emphasis on working theories as a mode of knowledge development is entirely accurate!

Even the youngest children develop implicit theories about how the world works. The specialised neural circuits which children have at birth provide a deep intuition of several areas of knowledge and understanding. These include the physics governing objects and their movement, spatial navigation, numbers and probability, as well as the ability to recognise faces and seek out and communicate with other humans. Research demonstrates that very young infants can engage in organising and analysing information about the world to uncover patterns and develop conclusions. Children constantly seek experiences to gain more data that will enable them to test and refine these theories, so that they more reliably explain and predict the world. They collect information in spontaneous yet systematic and rational

ways. Their brains seek to identify common patterns across acquired information, fitting it into an existing model of the world, or adapting their model to better fit the data, gradually working towards developing the coherent, generalised, and highly structured representations about the world that support them to make predictions and develop plans. These are 'working theories' because they are always fluid and capable of change, and become more complex, more interconnected, and more useful with time and experience. Learning involves a gradual unfolding of understanding characterised by corrected errors, revised misconceptions, and expanded ideas. Developmental science has demonstrated a succession of different and increasingly accurate conceptualisations of the world in children as they develop.

This means that learning takes place in the context of previous understanding and knowledge, and new understandings are built on top of existing understandings. Strengthening children's prior learning and building new synapses (connections between neurons) upon it creates stronger connections and pathways between neurons. Children learn about new information or new processes in the light of what they already understand and know, and it is more difficult for them to understand, learn, or remember something that is totally unfamiliar.

Scaffolding is a specific teaching strategy that accommodates children's prior learning and skill level while using various teaching techniques to help the child reach a higher level of thinking or capacity in relation to an activity. In order to scaffold children's learning, teachers need to provide challenge at the right level within the child's zone of proximal development. In the zone of proximal development, teachers support children at the cusp of what they are able to understand and do – in other words, with skills, dispositions, or knowledge that are newly emerging, and that require some assistance or encouragement. This requires knowledge of the learning needed as well as of the child's capacities, understandings, and needs in relation to it. The level of challenge is different for each child, changing with task and context.

Note that many contemporary Vygotskian academics prefer the terms 'guided participation' and 'co-construction' rather than scaffolding. When children co-construct knowledge with adults, they can still benefit from adult guidance, at the same time that their contribution to the learning is acknowledged so that their existing understandings are both valued and built upon. Rather than positioning children as mere novices, co-construction and guided participation offer children more agency in the learning they do in relationship with others. It is important to recognise that it is not only through their active experimentation and exploration that children gain statistical information to refine their internal models and theories, but that they also can do this through watching the experimentation, exploration, and activity of others in group situations.

When building on prior learning, it is important to:

- **Individualise learning** through guided knowledge construction. Respect what children already know and can do, and use this as the basis for them acquiring new knowledge.
- **Create opportunities to draw out and explore children's emergent understandings, ideas, and working theories**, and use interactions to highlight links with (rather than simply provide) new concepts, knowledge, and activities to extend those understandings. Children benefit from having teachers structure their experiences and point out the relevant similarities and differences.
- **Match the amount of support you offer to the skill level of the child**, and monitor their progress, ensuring you provide just enough but not too much support. Reflect on what you have seen the child do before, and how much help they are likely to need to successfully achieve their goals to determine what kind of interactions will help. If the child falters, provide more support, and decrease support to encourage more independent action as they become more competent. Embed newly learned skills into new contexts.

- **Use guided participation and co-construction to extend children in all areas of the curriculum**. For example, use children's observations about the world, such as the growth of a particular plant in the garden, to think about scientific explanations. However, avoid 'hijacking' the conversation for your own ends, instead expanding and extending on children's ideas within a supportive and warm environment in which you acknowledge and appreciate the child's efforts and understandings.

Use authentic and meaningful contexts

Children learn best if they are attentive, focused, and active, and this can best be achieved through activities and experiences that they perceive as meaningful and useful. Due to being immersed in the activities of their cultural groups, children are likely to view the everyday activities of their community as relevant and meaningful. Research shows that, when the content for learning abstract concepts involves objects and ideas familiar to children from their everyday life experiences, they are able to achieve greater success. Authentic and meaningful contexts also support children to become absorbed and to learn in deep way through a range of holistic learning opportunities which promote rich and interconnected understandings. Learning holistically in authentic contexts enables children to make effective neural connections.

Children's interests provide meaningful and intrinsically motivating activities for children, involving them in exploring and acquiring a range of skills, knowledge, and understandings. Drawing on and extending children's interests as a source of curriculum is especially important for early childhood education, as children's attention and self-regulation are still in development, and their capacity to attend to events and objects that they are not naturally interested in (a highly sophisticated executive function skill) is limited. However, it is important that children's interests are also embedded in authentic contexts for their exploration. 'Hijacking' an interest or theory of children to serve an adult's teaching agenda can create distance in the relationships between teachers and children, whereas true intersubjectivity and attunement depend on an authentic connection with the topic of interest.

When creating authentic and meaningful contexts, it is important to:

- **Involve children in authentic and meaningful everyday tasks and authentic cultural contexts**, in which children can learn from guided participation and being mutually engaged in activity alongside adults.
- **Notice and document children's emerging areas of interest** and expertise, and support them to become interested and knowledgeable in at least one topic, which is linked to children's propensity to ask questions and take initiative in conversations.
- **Offer a range of ways of engaging with learning**, as some children might be supported most effectively through narrative, and others through hands-on construction and creativity. Learning opportunities need to offer multiple points of entry for young children. Exploring ideas in more than one 'language' can strengthen brains.
- **Don't underestimate children's capabilities in an area of interest**. When children accumulate a large amount of knowledge in an area of interest to them, they can perform at a level far exceeding expectations, including working with abstract categories, classification schemes, and structures. In some situations children can be more knowledgeable than teachers, and interactions focused on knowledge-sharing are valuable contexts for children to practise explaining, using and defining specialist vocabulary.

Mediate and support learning through intentional interactions

Children learn to think (and, particularly, to use language for thinking) in the context of social relationships and interactions. Children therefore make greater progress when they experience quality verbal interactions with teachers, including open-ended questioning, sustained shared thinking, formative feedback during activities, and modelling of skills, dispositions, and behaviours. These interactions and modelled skills and behaviours are a form of mediation or intervention into the child's cognitive and behavioural processes, expanding and strengthening particular modes of thinking and acting.

Mediation is particularly important when there are key ideas and concepts that teachers aim for children to discover and learn. There is substantive research which demonstrates that children can have great difficulty discovering abstract rules and understandings from their play and activity without some guidance from an adult. Increasingly, research shows that for learners of all ages, explicit teaching of ideas and concepts is helpful, especially when accompanied with hands-on practice. The strategy of intentional teaching refers to the way in which teachers are encouraged to have specific and clear goals in mind when working with children, focusing their mediation on supporting children to understand particular things or develop particular skills.

Successful interactions for learning pull children in and along, so that effective learning is based upon a smooth and meaningful exchange. While questioning is valuable, there are negative effects associated with stringing many questions together. A higher frequency of questions from the teacher reduces the likelihood of children using initiative, elaborating or following up their response with additional and unrequested information, and is associated with shorter utterances overall. Children are more likely to give low-level replies, which means that increasing questions will not increase children's level or amount of reasoning, remembering, or hypothesising. Responsive interactions, in which children's interests are placed at the centre of the dialogue, are best, while displays of power and status (teachers being overly directive or dismissive of children) can negatively influence the flow of interactions. Research finds that even short exchanges that are a minute or so long are a rich context for learning and teaching. Attention to details such as these ensures that intentional teaching remains responsive, and doesn't stray into the tendency to 'hijack' children's interests in the service of specific learning goals, as described above.

When implementing intentional interactions, it is important to:

- **Make oral language development a priority**. Use 'parentese' (higher intonation, careful enunciation, slower pace) with infants to gain their attention, and encourage imitation or response. Use your responses to children's utterances to scaffold more complex language, add linguistically and cognitively challenging input, and offer vocabulary to accommodate new ideas. Use sophisticated and varied vocabulary in a way that children can understand your meaning, and use words or concepts in different contexts.
- **Seek to maintain conversation on a given topic.** Repeat children's responses to your questions, or include their words directly into a subsequent question, rather than offer an evaluative response, and pause to offer children opportunities to speak. This can help them to keep talking! Try to find a connection to the topic raised by the child, add new information that is contingent on the child's contribution, encourage them to clarify their meanings, and provide opportunities for the child to contribute their own knowledge. Use fewer 'controlling' moves, such as questions or monitoring and managing conversational turns.
- **Engage children in cognitively challenging conversations.** This could include: personal narratives, explanations, re-creating events, sharing opinions and ideas in pretend play, analysing and comparing experiences and different ways of doing things, and theorising about how things work. Give

children information when they need it, but not too often as they may become passive, bored, and disinterested. It is far better to maintain children's curiosity by suggesting (or admitting) that you do not know everything on a given topic and there is much more to learn! Constantly feed children with questions that stimulate their imagination and make them want to go deeper.

- **Ask both low level and higher level questions**. Lower level questions elicit labels ('do you know what this is?'), descriptions ('what do these look like to you?') and recall ('what do these remind you of?'). High level, cognitively demanding questions provide opportunities for children to examine their previous concepts and understandings, and encourage explaining, imagining, interpreting, predicting, and forming opinions. Actively rephrasing ideas in their own words helps children to digest new concepts. Avoid question sequences, repeating the same question until the children answer it, repeating children's answers, answering your own questions, whole group questioning, and chorus answers, which are demotivating.

Allow for experimentation, consolidation, and practice

Play provides an emotionally safe context in which children can explore their identities and test out their ideas and theories. Play is a key way that children gain that statistical information they use with which to test their theories. Scientific knowledge from various fields agrees that a passive organism learns very little. This means children need to be actively engaged in exploring, generating hypotheses, and testing them on the world. The informal experimentation that children (and adults) engage in during play is powerful for learning, leading to theory change. For example, through their interventions on the world, children learn about causal structure (and you will note that children repeat their experiments, just to check what happens every time they fill a bowl with water, or when they drop something from height. As children practise skills and reflect on information, the neurons that encode these skills and knowledge are strengthened. The more a child is encouraged to test their knowledge, the more they learn. To learn, children's brains project a hypothetical mental model of the world onto their environments, and compare it to the information they receive through their senses. Every unexpected error leads them to adjust their internal model of the world.

Neuroscience has demonstrated the importance of repetition as a key way in which brains are built. Synaptogenesis is the process of creating, stabilising, and consolidating or eliminating synapses (connections between neurons). The repetition of experiences is important for ensuring that synapses are maintained and elaborated. To streamline children's thinking and make it more efficient, only what is needed is kept, which means unused synapses are quickly pruned or eliminated. Repetition is essential for promoting neural growth and learning, as the more something is experienced, the stronger the connection and pathway that is created in the brain. Repeated stimulation causes synapses to grow and become permanent, while synapses that are not strong enough or are not being used are pruned, to make room for new connections between neurons. This 'synaptic pruning' streamlines children's connections so that they are more efficient and are processed more quickly. Neuroscience reinforces ideas about effective curriculum as offering children plenty of opportunities to practise skills and explore ideas in many different contexts.

When implementing experimentation, consolidation, and practice, it is important to:

- Allow plenty of time for free play, but combine this with periods of more intentional teaching. For example, you might demonstrate to children how to construct a water filter with various materials, and then provide time for children to explore and discover on their own.
- Be present during children's play and activity to help draw out what they are learning.

Develop children's capacities for learning to learn

Infants already observe, think, and reason as they interact with the world, and children spontaneously develop strategies to help solve problems at an early age. Children can be taught learning strategies and metacognitive skills to help them monitor their thinking and learning, as well as developing theories about how they learn, which affect their behaviour within situations where effortful learning is required. When children understand the learning process, they can be more motivated to continue with learning activities, rather than believing that they simply don't know or can't do it.

Making errors (and being supported to correct them) is an important part of learning. The brain learns only because it perceives a gap between what it predicted it would see or experience (from its internal models and theories) and the information it receives about what actually happened. It is important that children receive timely, accurate, and high-quality feedback, which can take the form of a comment, a question, or even a gesture or demonstration.

Mental tools or strategies include trial and error, developing analogies, or relating information and ideas. These are usually learnt from other people through the use of questioning, modelling, and demonstrating. For example, children's invented stories improve after they have had storytelling modelled to them. Children who can use a broad range of learning strategies tend to be more successful in problem-solving, reading, and text comprehension.

When implementing learning to learn, it is important to:

- **Specifically explain, and make explicit, learning goals** that you are pursuing for children. Comment when you observe those desired learning dispositions and goals in order to direct children's attention to this aspect of their learning and scaffold learning further in the direction of the goal. Model the actions and behaviours of an effective learner yourself, for example, by finding reference material when you are stuck with a drawing, or asking a friend to show you how to do something.
- **Aim to strengthen the learning dispositions identified as priorities for learning in your setting** by increasing their frequency, expanding the contexts in which they are used, and deepening their complexity. Orchestrate resources and activities to create an inviting environment for that particular learning goal or disposition. For example, if you are seeking to strengthen children's dispositions and abilities to collaborate with one another, choose activities and resources that make collaboration necessary and attractive.
- **Have conversations with children about their learning journeys** as you revisit and review children's portfolios and other documentation. Use phrases such as 'Remember when…?', 'you couldn't do this last week', 'this looks different', and 'how did you learn to do that?'. Emphasise the learning strategies (practising, planning, etc.) that were used. Encourage children to reflect on their learning and develop stories about themselves as learners. Support them to become aware that their intelligence is not fixed and that they can grow skills and knowledge with practice, experience, and effort.
- **Develop a learning language with a wide vocabulary**, including words such as 'practising', 'being resourceful', 'being an author/ scientist' and 'trying hard' and apply them to concrete examples of children's learning.

Curricular programmes in early childhood can take many different forms and reflect local and unique priorities, but are likely to support children's learning more powerfully when underpinned by the principles of effective learning identified by research. This means curricular programmes should be focused on building on children's prior learning, promoting learning to learn, and mediating learning, practice, and

experimentation within authentic and meaningful learning opportunities, within a context focused on children's wellbeing, positive relationships, and interactions.

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