Intergenerational learning: grandparents teaching everyday concepts in science and technology[1]

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Abstract

For many grandchildren their grandparents are 'special' people, and the time they spend together often generates memorable experiences and conversations that are educational. Yet society underestimates the impact that grandparents have as mentors and role models for children. Through spontaneous, shared activities grandparents support the science and technology learning of their grandchildren. In this article, informed by socio-cultural theory, we draw on Vygotsky's everyday and scientific

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concepts, as well as interpsychological and intrapsychological functioning. Analysis involved highlighting the important co-construction that occurs through these informal intergenerational interactions. Our findings highlight the significance of these shared conversations in relation to children's emerging everyday concepts in science and technology. The analysis identifies the significant role played by older generations in developing children's understanding of natural phenomena and how things work. Implications of our study highlight the benefits for children when the everyday concepts they bring with them into the classroom are valued.

The need for the study

In his book *Idolising Children* Daniel Donahoo (2007) a 29-year-old father of two young boys who lives with his wife in Central Victoria, contends that "Grandparents help to place us in our context" (p. 219) and "we underestimate the impact that limiting our contact with grandparents may have on society" (p. 233). An Australian survey carried out a few years earlier revealed that 19% of children younger than 12, were in the care of their grandparents on a regular basis (Australian Bureau of Statistics, 2003). When looked at as a group, grandparents are diverse in many ways such as age, cultural heritage, health status, present and former occupations, marital status, relationship with their adult children (and their spouses or former spouses), proximity to grandchildren, and amount and type of intergenerational contact (Wearing & Wearing, 1996; Earle, 1999; Rezac, 2002; Grandparents Australia, Inc., 2004).

Several studies report that cultural issues form a significant factor that affects grandparenting. Goodfellow and Laverty (2003) identify a strong socio-historical factor in their study on grandparents' satisfaction and choice in their role as carers of their grandchildren. The study findings showed that there was potentially a stronger commitment among grandparents born in non-English-speaking countries, and English-speaking countries other than Australia, to "family care and contribution, and passing down of cultural and family traditions (ways of doing things) across generations" (Goodfellow & Laverty, 2003:18) than among Australian born grandparents.

In their study of Australian-Vietnamese grandparenthood, Vo-Thanh-Xuan and Liamputtong (2003) relate that while these grandparents generally have established

close grandparent-parent-grandchild relationships and feel emotionally fulfilled, this has come at the expense of many changes in their lives and relationships with their children/grandchildren in their new homeland, and the consideration and acceptance of many new values.

Despite the challenges, many grandparents have deep and rewarding relationships with, and commitment to, their grandchildren. Potentially their shared experiences and interactions are mutually beneficial, enjoyable and educational, yet frequently the value of such interactions is not recognised. Thus there is a need for our study that documents examples of how grandparents are supporting their grandchildren's learning.

Research questions

Our study was shaped from a socio-cultural perspective, where development is understood as a cultural process, and people develop through their varied participation in the changing cultural activities of their communities (Rogoff, 2003). Several of Vygotsky's concepts were drawn upon, namely, mediated action, intermental and intramental functioning, and everyday and scientific thinking, all of which are relevant in considerations of intergenerational relationships. In our study we investigated the following research questions:

- What science and technological experiences do grandparents, from a range of cultural heritages, engage in with their grandchildren?
- How do grandparents support and extend their grandchildren's learning in science and technology?
- What are the benefits of these intergenerational conversations?

Socio-cultural informants for research

As mentioned above, people develop through their changing participation in the cultural activities of their communities (which in turn also change). These ideas are inherent within socio-cultural (or cultural-historical) perspectives, which maintain that people, contexts, actions, meanings, communities and cultural histories are all mutually constituted. From this perspective development is seen as a process of

participation with others in activities that are mediated by cultural tools, and are constituted with and by interpersonal and community or contextual factors. Socio-cultural theory derives from the work of Vygotsky and his colleagues in the early twentieth century. Three important Vygotskian concepts are discussed below.

Mediated action

A fundamental element of Vygotskian theorising is the concept of mediation. He argues that higher mental actions are mediated within activities by tools, artefacts and cultural inventions (for example, different kinds of numbering systems and counting, mnemonic aids, algebraic systems, art works, writing, schemes, diagrams, maps, drawings and all sorts of conventional signs) (Vygotsky, 1997). Other tools recognised in sociocultural discourse include paintbrushes, computers, calendars, and symbol systems (John-Steiner & Mahn, 1996), although for Vygotsky speech was the most important tool (Wertsch, 1990). These tools and signs being social in origin are used to communicate firstly with others, and secondly to mediate our interaction with self (Moll, 1992). Most tools and artefacts bring a cultural inheritance with them, and by learning to use these artefacts, and the practices in which they are used, people integrate the experiences of their society (Wells, 2000), or as Säljö (1998:55) wrote, "...the world is pre-interpreted for us by previous generations, and we draw on the experiences that others have made for us". Tool-based 'mediation is first intermental and then becomes intramental as children learn to regulate the mediational cultural tools with their own social and mental activity' (Lantolf, 2003:350).

Intermental and intramental functioning

Another important Vygotskian principle is the notion that thinking progresses through 'intermental' functioning to 'intramental' functioning. That is, thinking occurs first on the social plane (*between* people engaged in joint sociocultural activity), and later on the individual plane (that is, *within* the child). Hedegaard (2001) explains:

> In Vygotsky's theory, learning is a social process that takes place between people. He conceptualized learning as internalisation of social interactions in which communication is central. Learning takes place in social interaction in a specific context which comes internalised by a person. By internalisation, Vygotsky did not mean copying but **transforming the external interaction to a new form of interaction** that guides the child's actions. Internalisation does

> not directly mirror the external social relations; it is a transformed reflection (Hedegaard, 2001:16-17; our emphasis).

Rogoff (1998) contends that the concept of internalization has been used in several theoretical approaches to describe how shared thinking (or intermental functioning) results in changes in the thinking of the individual (intramental functioning). However, she argues that the idea of internalisation implies that there is some sort of 'boundary' between the individual mind and the external social world, and this differentiates what she sees as the 'social add-on' or 'social influences' approach from sociocultural theory. From the latter perspective, learning and development are creative processes that occur through a changing participation in activities, not via internalization across a boundary. From this 'transformation of participation' perspective, an individual is continually in the process of developing and using their understanding through participation in shared endeavours in sociocultural activity (including endeavours shared with grandparents). "In the process of participation, individuals *change*, and their later involvement in similar events may reflect these changes" (Rogoff, 1998:689).

Everyday and scientific thinking

Vygotsky emphasised that the process whereby children acquire concepts, is mediated by speech. Through a series of experiments, he demonstrated that children acquire important concepts not only inside school (scientific concepts) but also outside (everyday concepts) and, that both are important and related (Panofsky, John-Steiner & Blackwell, 1990). Vygotsky used the term *scientific* (academic or scholarly) *concepts* to refer to ideas that have explicitly been introduced by adults in school, and sometimes by parents (van der Veer & Valsiner, 1993) (or other adults such as grandparents). Scientific concepts begin in the domain of conscious awareness and volition, and form a logical system in a particular discipline. They are generalisable, removed from material experience and exist within a hierarchical network of related concepts (Vygotsky, 1987).

These concepts contrast with *spontaneous* or *everyday concepts*, or those concepts that develop within children's daily lives as a result of their interaction with adults, peers and the non-social environment. Vygotsky saw the two types of concepts as interdependent. The development of scientific concepts in school depends on a previously developed set of word meanings stemming from the child's everyday

experiences, and this spontaneously acquired knowledge mediates the learning of the new scientific concepts (Panofsky, John-Steiner & Blackwell, 1990). For example, children will not readily understand scientific concepts such as 'technical systems' if they do not have the everyday concepts of things such as computers and switches, or music boxes and levers. When children learn scientific concepts, their understanding of switches and computers, music boxes and levers, changes.

According to Vygotsky (1987), both scientific and the everyday concepts have their strengths and their weaknesses. The strength of the scientific concept (such as technical systems) is that it is "embedded in a whole, connected, conceptual structure that supposedly reflects the true nature of the subject one is talking about" (van der Veer, 1998:91). As scientific concepts are explicitly taught, children commonly can relate their formal properties and consider their relationship with other concepts. However, a potential weakness of these concepts is that they may be beyond children's personal experience, and thus may not be truly meaningful or relevant (van der Veer, 1998). In contrast, the strength of everyday concepts is that they have arisen from personal experience, rather than having to memorise. A disadvantage can be that they are only applicable within specific contexts or activities (van der Veer, 1998).

Research Method

Given that Vygtosky (1987) emphasised that everyday concepts are embedded in children's life experiences and natural conversational contexts, it was important for us as researchers to attend to activities children participate in at home and in the community, and to the significant relationships (including intergenerational relationships), artefacts, meanings, actions and histories within those contexts and activities. In attempting to do this, a useful research tool we employed was Rogoff's (1998) three foci of analysis, where the personal, interpersonal and community/institutional issues of any activity can variously be highlighted. This tool enabled us to highlight individuals or groups of children (and/or adults) and identify how they are 'transforming' as they participate in everyday activities (personal focus of analysis). It also enabled us to consider factors such as 'shared' understandings and the important interpersonal relationships that are structuring and supporting these understandings (interpersonal focus of analysis). In addition, we were able to highlight particular community constructions of science and technology and

determine the value that is placed on science and technology within that community, as well as specific cultural tools or artefacts available (or not available), and the history these tools and the social players themselves bring with them to the activity (community/institutional focus of analysis). While we brought one of these foci to the forefront, the others remained within the background, and therefore formed part of the analysis. Importantly, through this tool, we highlighted the multiple pathways to learning within the community.

The study reported here involved twelve sets of grandparents/grandchildren as participants, and we focused on the shared, spontaneous, cooperative activities that were recognised as science and technology in nature. Qualitative research methods were used and triangulation of data included collecting evidence of examples of the interactions that occur between grandparents and their grandchildren. Data collection involved:

- Documenting the activities they engage in together by capturing the experiences using disposable cameras, distributed to all participating grandparents.
- Written accounts in journals kept by grandparents, that record what was said and done during these experiences.
- Informal discussions with some grandparents to expand on, explain, or further reflect on details in the journals or photographs, and their shared experiences.

Using Rogoff's (1998) three foci of analysis as a research tool we analysed the photographs, grandparents' journal entries and discussions, to determine:

- The children's learning (everyday and scientific concepts) that is occurring through the shared activities, particularly learning of a scientific and technological nature.
- The psychological processes (intramental to intermental functioning), which are occurring.
- The nature of the conversations between grandparents and their grandchildren.

Discussion of the findings from a socio-cultural perspective

A socio-cultural analysis of the data generated indicates that there are several ways in which grandparents are supporting young children's scientific and technological thinking and learning. The findings are addressed in the following three sections:

- Transformational issues (the personal lens);
- Relationships and collaboration (the interpersonal lens); and
- Valued experiences and cultural tools (the community/contextual lens).

Transformational issues (the personal lens)

Consistent with Rogoff (2003), while focusing on a particular child or grandparent, we also drew on information available to us through the interpersonal or community/cultural lens. We found that the children in the study are developing rich, everyday concepts and creative thinking through their participation in shared, informal activities with their grandparents. Through participation in simple, but meaningful activities, such as gardening, cooking, mending, cleaning, playing in the sandpit, going to the beach, walking in the park, and having a picnic, children's understanding is being developed and transformed through participation in these mutually enjoyable and relevant activities. These spontaneous, everyday concepts provide the concrete experiences necessary for activating the scientific concepts they will encounter at school. Below we present several examples that illustrate the kind of activities that help children develop everyday concepts that involve science or technology.

Example 1. Oliver (5 years and 9 months) demonstrates he has learned about processes and systems, and has developed certain technological understandings. During a visit by his grandparents from England, he showed them how to log on to a computer and send each other emails. The grandparents made this entry in their journal:

> *He showed us the computer and we were surprised that he knew how to log onto the computer for himself. He said that Mummy had showed him but that he wasn't allowed to go on the computer by himself. We are going to let him log*

onto the computer for us when we record our journal (Grandparents Peter & Kathleen)

By sharing this information with his grandmother, Oliver was not only able to demonstrate and teach her his developing computer skills, but he was also preparing for future engagement in similar activities on her return to England.

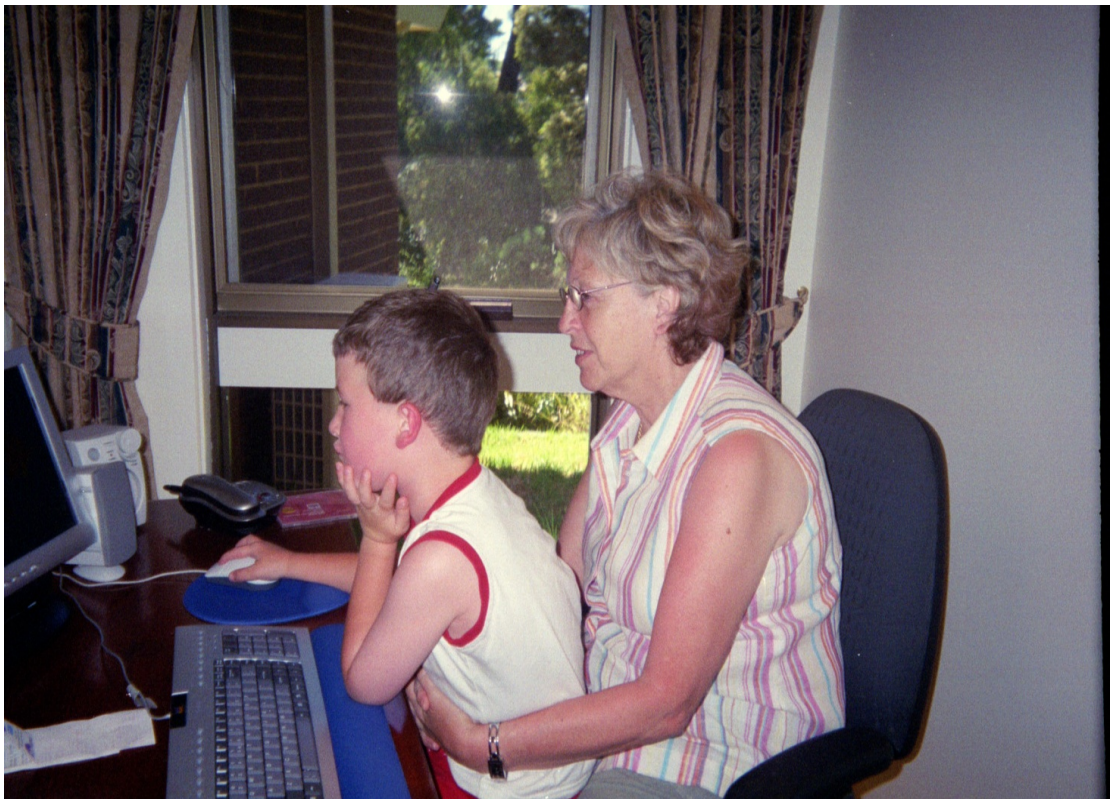

Figure 1: *Oliver and his grandmother logging on to the computer*

Example 2. The following extract from a grandmother's journal illustrates how Annika (2 years old) has learned to operate a simple machine.

Each visit to my parents' (great grandparents) home, Annika carefully will bring this piano music box over to my father to hold. She then opens the top, stands with hands behind back and listens. After a few minutes she will (with her index finger) press the small lever to stop the music. My father has only pressed the lever once, to show her how it stopped; she obviously remembered. (Grandmother of Annika)

Transformational experiences such as these involving Oliver and Annika, are not only important in developing everyday concepts such as those of computers and switches, music boxes and levers, but more broadly they lay important foundations for their later development of abstract, scientific concepts such as 'systems' encountered in technology classes at school.

Example 3. Another grandmother, Margaret, who made a DVD to record the science and technology experiences she engaged in with her grandchildren, interspersed current footage of Owen (6 years) engaged in complex block building with footage of him completing puzzles at fifteen months. The concentration that Owen demonstrated as a toddler, supported at the time by his grandmother, has now transformed into the ability to build intricate constructions. In the process, and the accompanying talk with his grandmother, he is now demonstrating advanced technological skills of designing, making and appraising.

Example 4 . The following journal entry by the grandmother of Ethan (4 years) illustrates the transformation that is occurring in his thinking through experimentation and her support. Building on his fascination with the properties of light, his grandmother initiated several activities that involved exploring how light travels and behaves when it hits an object. By holding a mirror towards a window Ethan explored how light was reflected when the incoming sunlight hit the mirror. He quickly discovered that the angle of the mirror determined the position of the light beam on the wall. Furthermore, he talked with his grandmother about shadows, and the photograph below shows Ethan and his shadow early one morning. Several days later Ethan told her that his shadow was shorter now. This episode shows that his thinking has evolved to the point that he recognise that the length of his shadow changes. Significantly through these activities,

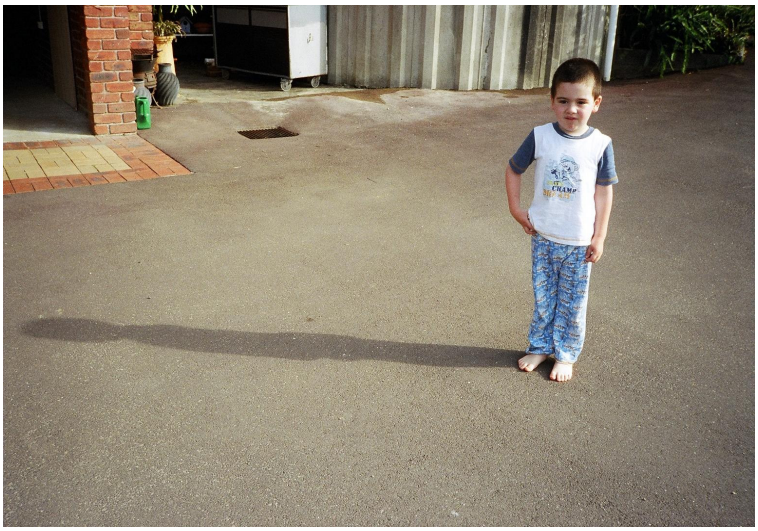

Figure 2: *Ethan and his long shadow*

his grandmother has been supporting Ethan's development of both everyday *and* scientific concepts.

When viewed through the personal lens, each of the above examples illustrates the transformational nature of children's scientific and technological thinking. However, they also demonstrate the interweaving character of the personal, interpersonal and community/contextual. Although we might choose here to focus on individual children (personal focus of analysis), their thinking may not have evolved without interactions with their grandparents (interpersonal focus of analysis), or without specific cultural tools such as computers, music boxes, mirrors and blocks (community/contextual focus of analysis).

Relationships and collaboration (the interpersonal lens)

The interpersonal lens allows us to focus on what people are doing together and how learning is occurring 'between' them, rather than simply in an individual child. It also can highlight where thinking is moving from an intermental to and intramental level, as children increasingly internalise and reflect on the evolving understandings.

Example 4. A conversation with Ethan's grandmother, illustrates how there has been a shift from thinking occurring on the social plane (between people engaged in joint socio-cultural activity) to occurring on an individual plane (that is, within the child).

> *Ethan is in preschool now, and he's more independent in his thinking. For example, see that plant over there. A while ago, Ethan and I would have looked at the plant together and talked about it. He'd have asked me questions about it, and I would have told him about various parts of the tree. Now, he is noticing things before me, and drawing* ***my*** *attention to things... and telling* ***me*** *about them...* (Grandmother Lois)

Example 5. The following extract, relating to Oliver's visit to the beach with his grandparents, illustrates how they are aware that his thinking is gradually evolving. While it would seem that, at present, his thinking is still at times occurring on an intermental level, their comment that his questions are becoming harder to answer, indicates that he has internalised the shared understandings built with them during previous experiences, and he can reflect on that understanding. Over time, his thinking has gradually shifted to the intramental level.

> *We went to the beach with Oliver and he wanted to know why there were dead jellyfish on the beach and why there were bits of glass that were really smooth. He loves asking questions and often you have to think pretty hard to come up with the right answer. One of the questions he asked was, 'Granddad, where does the sea go when the tide goes out?' When he was younger you knew that you would be able to answer all of his questions, but the older he gets the harder the questions get.* (Grandparents Peter & Kathleen).

These intergenerational interactions benefit not only the grandchildren, but grandparents as well, as the following example shows. "It's a big commitment, but they give us back so much. We wouldn't have it any other way" (Grandfather Mike). Similarly, Ethan's grandmother also reports on the 'special times' they share together: "Our time together is special. He relates to me in a way that is different from how he relates to others. We just enjoy being with each other - just spending time talking..."(Grandmother Lois). Such times of intergenerational sharing can be a form of relaxation and enjoyment for grandparents, and reinforces feelings of 'being wanted'. In addition, by engaging in joint everyday experiences, the grandparents' values become valued by the grandchild.

Valued experiences and cultural tools (the community/contextual lens)

Most grandparents in our study are signifying that they enjoy the time and activities with their grandchildren and also see it as important for the children to gain knowledge about their natural and physical world and the technologies that exist or can be created within them. This valuing of intergenerational activities exemplifies what Hedegaard (1998) wrote about the situated nature of learning and cognition, and the support that is given for culturally relevant activities. While supporting their grandchildren's explorations and activities, grandparents are often demonstrating what they see as important within their family context, or society in general. Margaret places great importance on her grandchildren's emerging interests in science, and has developed some 'science boxes' which she brings out when various grandchildren visit. Not all grandparents are so 'consciously' supporting the learning of science and technology understandings and skills. Most would not see themselves as knowledgeable in science and technology, nor are they aware of the embedded nature of learning, such as that evident in the following extracts.

Example 6.

> *Grandfather called in morning to take Jack and Nicholas to the park. Jack and other children inspected dead possum, possibly killed by car and noted the damage done and the dangers of walking out on the road* (G. & J. Field - grandparents of Jack & Nicholas)

Example 7.

> *Went to a Mornington market with Oliver and got him a set of mini gardening tools. He has his own bit of garden and he and his grandma have spent a lot of time together in the garden, picking fruit and pulling up weeds* (Grandparents Peter & Kathleen).

What is also evident in several of the journal entries by the grandparents is the cultural-historical nature of children's everyday thinking and activities. As a child actively participates in cooking with grandparents, reads a book together with other family members, or fixes a camera, the child draws on previous experiences undertaken by and with grandparents, and the conceptual links made directly with experiences her/his parent had as a child, or indirectly through the stories told by grandparents about when the child's parents were younger (Fleer & Robbins, 2004). The grandparents' 'voice' can also be heard in the voice of the parent (Bakhtin, 1981, 1986) even when the grandparent, or great grandparent, is no longer living, or as in this study, lives interstate or overseas. As Oliver's grandparents related: "It's great to see Oliver growing up. We can see our daughter in him, but ourselves, too."

Example 8. Likewise patterns of behaviour can often be seen across generations, as in the following journal entry by Annika's grandmother.

> *I pulled apart my Russian doll and Annika sat for several minutes, trying to put them back together. She placed them in a line with the 'head' parts in a row. This reminded me - when Anthea (Annika's mother) was this age she would line all her dolls and soft toys around the walls of the lounge room.* (Grandmother of Annika)

Example 9. Another significant contextual issue was that of time. Not constrained by time factors that increasingly appear to impact on interactions between ‘parents’ and

children, grandparents more frequently had the time to engage in unhurried activity with their grandchildren.

Figure 3: *Jack planting vegetables at his grandmother's house*

After returning from the park Jack (nearly five) and Grandpa drove off in the car to buy a sausage roll and pie and thence to Grandma's house to plant carrots and lettuces. Jack dug over soil and pulled out a number of worms. Grandma explained why worms were good for the garden and thus why we needed to put the worms back into the soil. Jack also asked why there were no mulberries on the tree. Grandma explained it wasn't the right time of the year and pointed out the tender shoots on the tree, which indicated the berries were coming and could be picked later in the year. (Grandparents of Jack)

Implications of the study and conclusion

In our study reported here grandparents took photographs of their grandchildren as they engaged in everyday activities. In their journals the grandparents recorded

descriptions of what the children were doing and saying as they participated in these activities. Many of these intergenerational, interactive activities were child initiated and took place in a range of contexts. Conversational and dialogic processes were rich and supportive. Vygotsky's ideas concerning the nature of intermental to intramental thinking, and everyday and scientific concepts, were helpful when we analysed the data using Rogoff's three lenses.

In response to research question one, although the majority of the grandparents in this study had elementary ideas of what constitutes learning in science and technology, they all were engaging in many and varied activities with their grandchildren that were scientific and/or technological in nature. Examples of these everyday experiences, include going for a walk in the park or along the beach, tending to plants in the garden, visiting the zoo, wildlife park or museum, and cooking in the kitchen.

In addressing research question two, we found that most grandparents listen attentively to what their grandchildren have to say. In turn this active listening encourages the children to verbalise their ideas. These intergenerational conversations help to focus the children's attention on the science in the activity and encourage the children's curiosity and sense of wonder.

Research question three turned our attention to the reciprocal nature of these intergenerational conversations. These conversations help the grandchildren to find relevance and meaning in the scientific concepts they encounter in school and prior-to-school settings. For example children's conversations with their grandparents about backbones and feet can help them understand the relationships between 'structure and function'. The children also develop self-esteem because the grandparents value the children's contribution to these exchanges. Similarly the grandparents benefit by being viewed as important and knowledgeable in their children's eyes. Furthermore, as the grandparents see the children become excited about everyday scientific phenomena, they in turn revisit and explore the phenomena in new ways. Thus reciprocal learning is occurring through these positive and shared conversations that build and enhance intergenerational relationships. Our study findings indicate that through participation in simple but meaningful everyday activities with their grandparents, children's technological and scientific understandings are being developed and transformed.

Our study has several implications for teaching young children. Firstly, the examples included here show that children come into classrooms with some skills and knowledge in science and technology. Children develop many spontaneous concepts through their engagement in activities in informal contexts. Often these understandings are actively supported and scaffolded by others. Secondly, as these shared understandings develop through mutual involvement in culturally appropriate activities, it is important for teachers to be aware that strong interpersonal relationships exist for children, and that shared understandings develop with significant others in their lives, especially grandparents. Thirdly, teachers have an important role to play in helping children to overcome the gap between thinking within and outside school contexts, and between everyday and scientific concepts. By acknowledging the prior learning and skills that children bring with them to school or preschool, and discovering the 'windows of opportunity' into children's thinking processes, teachers can build on these existing understandings and skills, and 'help them make the connections between the concrete and abstract' in science and technology.

This study is significant because even though many grandparents are increasingly engaging in the care of their grandchildren, there are few studies that recognise the important role grandparents take on when they foster their grandchildren's understanding of science and technology. Through documenting the shared activities we have provided evidence of these important intergenerational interactions. Unfortunately most people fail to recognise the valuable contribution the older generation is making to children's understanding of physics, chemistry and technology. Grandparents teach young children about natural phenomena and how things work through simple, everyday activities including visits to the beach, using a computer, cooking, gardening and even household chores. Our research showed that grandparents are encouraging children's sense of wonder and are stimulating learning, often without realising it.

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