A snapshot of science education in kindergarten settings

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Across Victoria, early childhood practitioners are incorporating science activities into daily experiences for their children. A small research project, which asked teachers to describe what they did in science and how they did it, has highlighted some interesting differences. This paper will describe case studies of four kindergarten settings and some of the experiences undertaken by the children—both as part of the formal program and through incidental play. It will consider these through a socio-cultural framework, noting how teachers used their understandings of play and language theories, to enhance children's understandings in science.

INTRODUCTION

If you view any young child at play, you quickly realise how much interest they display for the world around them. They are curious about the phenomena they observe and often interact with objects and situations in an effort to gain more information. They are trying to make sense of what they see, what they touch, what they taste and what they smell. In this way young children are natural scientists (Abruscato & DeRosa, 2004, p. 5). Many of these observations occur through the play of a child and it is the role of the Early Childhood practitioner to enhance these learning experiences by providing opportunities for children to explore the world around them.

In the safe caring environment of an Early Childhood setting, children can interact with the natural world, ask questions, and discover for themselves. Play is the vehicle for learning and practising—particularly in science. The Early Childhood practitioner should recognise the importance of, and provide opportunities for, learning science through play (White, Rockel & Toso, 2007).

The researchers visited a number of early childhood settings and observed first hand the play experiences of the children. Through their 'scientific' lenses, they identified many science based contexts and observed how the teachers also interacted with the children in these circumstances.

THEORETICAL UNDERPINNINGS

Play

'Play' experiences are part of every child's growth and development. Increasingly, play is being recognised as a powerful pedagogical tool through which to guide and enhance learning (Fleer & Ridgeway, 2007). Play based learning occurs when young children 'make meaning' through their exploration in a range of social situations. Interaction with peers, Early Childhood practitioners and significant others can stimulate children's curiosity to learn more and to ask questions. The role of the Early Childhood practitioner is to provide a physical environment which is rich in

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natural resources and through guided participation, help a child move past their own limitations of knowledge to develop deeper understandings. Play provides opportunities for problem solving, abstract thinking, higher-order thinking, creativity, independent learning, research, exploration of complex issues and complex language, literacy and numeracy skills (Dockett and Fleer, 2002, p210)—many of which are needed in learning in science. When exploring their environment and undertaking their own science investigations, children engage in many sorts of play such as drama, symbolic play, exploratory play and constructive play (Chalufour & Worth, 2005, p7). As stated by Tucker (2005, p.3) 'Play is undoubtedly enjoyable for young children owing to the freedom it facilitates, the sense of ownership it affords and the self-esteem it promotes. Through play children can repeat, rehearse and refine skills, displaying what they do know and practising what they are beginning to understand.'

The EC practitioner must 'acknowledge the importance of play as a platform for learning and practising the basic process skills of science' (Howitt, Morris & Colville, 2007).

Language-science links

In considering the science conceptual development of young children, language is a crucial and integral component. Vygotsky's view was that although initially language and thought developed independently in the young child, they eventually merged because of the social context in which children communicated with others (McInerney & McInerney, 1998, p. 39) Early childhood practitioners promote language development whilst recognising that children learn in different ways. This can be through the provision of enriched play experiences which include visual, auditory, small and large group aspects.

In developing these play experiences, there are different ways that the teacher can guide further learning, such as enriching the experiences through language, providing additional resources which stimulate children's questions, being a co-investigator with the child (a feature of what is termed Emergent Curriculum by Dockett and Fleer, 2002, p. 199) or asking effective questions which encourage further exploration. Modelling skills which young children can mimic may provide them with the opportunity to extend their own investigations.

In terms of developing understanding in science and mathematics, it is crucial that the language related areas of communication, connections and reasoning form a significant part of the child's early learning (Lind, 2005, p. 130). Language is used to clarify ideas and also to include mathematics and science learning in everyday communications of discussion and listening. As children engage in play experiences, their language skills will become increasingly complex over time (Dockett and Fleer, 2002, p. 94). A range of verbal scaffolding strategies aimed at effectively helping children to extend their knowledge, understanding and skills can be employed by practitioners (Dockett and Fleer, 2002, p. 194). They include: direct guidance, explanation, cues and questions, demonstration and modelling, goal and problem identification, planning, keeping on track, evaluating actions.

Whilst young children are excellent at mimicking adults and adult language, it is extremely important that the EC practitioner uses correct terminology in science experiences, couching the new words in familiar contexts (everyday literacy) until the child gains an understanding of the meaning of the word and the underlying science concept (the literacy of science).

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METHODOLOGY

As a small research team interested in early years science education and teacher professional knowledge, we undertook six month case studies of four early childhood settings, gathering data to describe the programs and experiences of the children and illuminate the practitioners' approaches to guiding science learning. The perspectives of practitioners were sought. The purpose of the research was two-fold. Firstly, we documented the program over time thus highlighting several issues to be considered for further research. We explored the structures, relationships and content of the experiences and the people involved. This entailed engagement of the interpretive categories of the social, educational and professional values, beliefs and attitudes of the main participants. Secondly, we wished to study, in particular, how the practitioners integrated science experiences into the children's learning.

Since this represented an interpretive study of a system that was 'bounded' in both time and space, we identified case study as the most appropriate methodology for its capacity to accommodate the complexity of this situation as it actively engages the changing dynamics of the settings and its social aspects (Campbell 2000). Additionally we recognized the validity of Stake's assertion (Bryman, 2001, p. 55). that 'The utility of case research to practitioners and policy makers is in its extension of experience'; and that case study centres on …research on a single case with a view to revealing important features about its nature' These considerations were found to be compatible with our own purposes in the project.

In our preliminary discussions we decided that a case study approach would be most appropriate as our basic intention was to seek to describe and develop an understanding of each educational program and setting rather than for the research to be an active agent in evaluating or changing the program. Stake (2000, p. 437) has called this an intrinsic case study as 'it is undertaken because, first and last, the researcher wants better understanding of this particular case'.

Each setting investigated is a 'bounded system' in a number of ways. From the physical perspective, it is located as a dedicated area and the buildings have been specifically designed with the program in mind. The children are isolated within their pre-school setting. A specific time frame was used, linking in with both intended science experiences but also to limit the amount of data collected. The teachers and children involved are positioned exclusively within this setting.

Clearly the system we investigated encompassed a range of educational, social and personal elements that were inextricably linked and formed the focus for the investigation. The research methodology needed to be sensitive to the constraints and opportunities that presented within the research project. McTaggart (1987 p. 7) states that case study 'is sensitive to particular contexts' and 'could provide a better knowledge of educational phenomena in general'. Rob Walker (1980, p. 4) has defined case study as

> The study of particular incidents and events, and the selective collection of information on biography, personality, intentions and values, all of which allows the case study worker to capture and portray the elements of a situation that give it meaning .

Our intention was to document and explore the structures, relationships, motivations and content of the program and people involved. Stake (2000) discusses how researchers '…aim the inquiry toward understanding what is important about that case within its own world…' He then describes the development of the interpretations of issues and contexts as 'thick descriptions'. Stake, 2000, p. 439).

We used a number of different data collection methods to study the social, educational and

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professional values, beliefs and attitudes of the main participants, and to develop our own 'thick descriptions' (Stake, 2000, p439) of 'intrinsic' situations. We have reflected on the data, providing our interpretation of the events, the participants and the context of this case study. Through this we hoped to 'describe the cases in sufficient descriptive narrative so that readers can vicariously experience these happenings and draw conclusions (Stake, 2000, p. 439).

METHODS IN PRACTICE

We gathered data through interviewing, direct observation, the use of photography and document collection to develop a number of interpretive accounts of aspects of the program. In addition, we used the approach of iterative reporting back to the primary audience of the program in order to improve the validity of the accounts.

Data collection methods

In collecting data, we used a range of well-accepted methods. Initially, a survey was sent to 75 Early Childhood Centres and Kindergartens in Victoria inviting the staff to respond to the questions which related to the science practices within the centre. We enquired about the general make-up of the centre to ensure that we understood the general background of each centre and we asked about the qualifications of the staff. The qualification categories lend themselves to discussions about the possibility or probability of staff having instruction in science education in any of their formal training. However, the responses of the survey will not form part of this paper. Staff members were invited: to participate in two interviews, for the centre to be observed and samples of programs or other public documents to be collected. Children were not interviewed or questioned or any aspect of children's involvement recorded. Data is therefore from EC practitioners' opinions and perceptions, researchers' observations and documents. We visited each of four centres several times for approximately one to two hours at a time. Each time we visited, we observed children at play for an hour and made notes of anything which was basically science related. In the initial 30 minute interview, we were seeking to find out what the teacher actually thought she did when she undertook science activities. Our questions were as follows:

Interview One—Questions

What is your own interest in science and where do you think that came from?

When you are completing your program, how do you make the decision on what experiences you will focus on?

When running a science activity, what learning do you look for in the children?

Do you formally report on the children's learning?

Where do you source your resources?

What approach do you use if a child asks you a question you can't answer?

The follow-up visit included time spent noting science-focussed activities. Our questions were an attempt to drill down on both the approach the teacher was using for discrete activities and to focus on how EC practitioners responded to children who were undertaking these activities.

Interview Two—Sample questions following an observed activity

Can you please explain what was happening at the start - as the introduction?

What part of the activity do you think gave the students opportunity to voice their thoughts? Is this an important aspect?

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Why do you use hands-on (or demonstrations, or big book reading) activities? (if this happened)

Did you expect the response you gained from children? Are you able to explain any differences to what you expected?

Explain …… to me (researcher describes an instance), I didn't really understand what was happening.

The second interviews tended to be a little more open and as such gave a broader appreciation of the work of the EC practitioner. Through their general responses, EC practitioners discussed their own philosophy about science and where they see it in their kindergarten as well as what they see as needing improvement.

------We were aware that play was considered the dominant pedagogy in most kindergartens (Fleer & Ridgeway, 2007) although occasionally, Early childhood educators will provide a focus on one or more activities which may have a science focus. As a consequence, we observed the play experiences of children to confirm for ourselves that each kindergarten did indeed follow that approach. The interview questions were also probing whether alternative approaches were used.

We were very aware of noting what scaffolding occurred and how the teacher used language to guide children as the research had indicated the powerful role language has in concept development (Dockett and Fleer, 2002, p199).

RESEARCH RESULTS

In analysing the data, we initially developed a case study for each setting and used our observations and the responses from the two interviews to construct an interpretive view of what science was happening at each centre.

Case study One

Setting:	4 year old group, small community kindergarten, government supported. Total number of student in the setting=25.
Director:	Experienced, 33 years. Bachelor of Early Childhood Studies
Assistant:	Not qualified.
Teacher:	Diploma of Teaching Early Childhood

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Question	Answer
What is your own interest in science and where do you think that came from?	I married someone who was doing agricultural science and who ended up teaching science and biology. My own children were interested in science and so were the children at the kinder. So its been in my life…
When you are completing your program, how do you make the decision on what experiences you will focus on?	Usually from something the kids may have asked me. We expand on a conversation… If possible, I will introduce an activity immediately, based on previous experience. Then I will take it further across a number of weeks. If the children don't come up with an idea, I willseet up an exploration table
When running a science activity, what learning do you look for in the children?	We talk with them, observe them, try to get an explanation from them, possibly even tell them what's happening. You can't predict what the thinking is about because not all children will be on the same level Some will think about it and take it further, others will just enjoy it for the 'fun' of the activity
Do you formally report on the children's learning?	I take photos of the children and annotate what the photo is about. I link this to my program book where I write what we did, and why we did it. I compile the photos into an individual portfolio for each child and
Where do you source your resources?	Apart from my husband, I use the internet and books. I also buy materials whenever I see them. I have a budget for kinder and apart from office materials, can essentially use the money in whatever way I like, so I buy lots of 'sciencey' things.
What approach do you use if a child asks you a question you can't answer?	I tell them I don't know but I'll find out for them. And I do, I'll go and find our and come back and tell them. I also say 'You ask mummy and daddy and see what they say'.
Any other comments?	I think science is so incidental with no matter what you are doing with the children, it's always there, whether it's a maths concept of a language concept or something, science is always popping into it. Everything you do always comes back to science and I think it is an important part of what the kids are doing.

Whilst the kindergarten has no specific policy relating to the content of what is taught, it is clear that science plays an important role in the experiences delivered to the children. The kinder involves children in a range of different experiences such as: magnetism, cooking, animal observation, changes of state (chemistry), natural phenomena observation (wind/air, plant

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growth), solar system/space, and dinosaurs. These experiences are supported by interest centres, books, discussions, excursions, incursions and computer programs.

Staff members are provided with a number of science professional development activities through the Regional Kindergarten Association and Kindergarten Teachers' Conference days. In addition to this the staff members undertake personal research on the internet and through books. They believe that they need additional professional development to enhance their understanding of science and provide them with further activities which will teach children about science through participation and discovery. They particularly seek hands-on activities presented through workshops, which could easily be incorporated into current programs.

After observing the centre over a number of visits it was concluded that science was indeed present in just about everything delivered. In particular, it was clear that the teacher used a strategy of rich language and open questioning to focus children's observations and for guided discovery. The teacher was very adept at using any play situation to ask expansive questions related to science knowledge and understanding. It was also clear from the questions that were being directed towards children, that the teacher's own science knowledge was quite good. This was also obvious because of the way in which she used correct scientific language when speaking to the children. In further discussion, the teacher revealed that her husband was a science teacher and she had been using him as a source of information for many years. She also commented that her interest in science had grown as she found that children were so naturally absorbed in all science things.

Example 1—A science experience arose out of children's play with snails. After spending some time watching the snails in the garden, the children collected them into a container and added leaves from the plants surrounding the habitat. The children placed the snails on the ground and were watching the way they moved. Very quickly, this turned into a 'race' to see which snail would win. The teacher added water to the pavement. At this point one of the children observed that the water was still moving – it was in fact running down a very slight incline. The teacher questioned the children asking them why they thought the water was still moving and where they believed it might go. One child was able to indicate that the path must be sloping and actually predicted with reasonable accuracy where the water would travel. In addition to the questions related to water movement, several of the children were asking the teacher why she had added the water. Rather than giving them the answer, she returned their question, asking for their opinion.

Example 2—A more formal science activity was observed, where the children were setting up a grass 'jungle' to house their plastic jungle animals. The teacher informed all children of the activity, but did not insist that they leave their play to join in. Consequently about 6-8 children wandered in and out of the activity at various times. As the activity proceeded, the teacher was continually asking the children questions related to the underlying science of the growth of plants. She introduced scientific language through using everyday language initially and then related this to the concepts developing through the activity.

Case study Two

Setting:	Regional city privately sponsored Early Childhood Centre, attached to a large private Prep–12 school. 4 year old group. Approximately 25 children.
Director:	Experienced 25 years, Bachelor of Early Childhood Education.
Assistant:	Diploma of Children's Services.
Teacher:	Bachelor of Early Childhood Education.

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Question	Answer
What is your own interest in science and where do you think that came from?	I don't have a strong background in science at all. There was some science in my degree but not as heavily specialised as other areas. I'd say it was my weakest area. I'm conscious of it so I make sure we integrate some science into our integrated program
When you are completing your program, how do you make the decision on what experiences you will focus on?	We teach very much to the children's interests and the questions that the children pose. It can come from us as staff because it's something we think the children would like to explore. We work in an investigative project way.
When running a science activity, what learning do you look for in the children?	I guess I am conscious of the science concepts but I am also very conscious of where the children's thinking is at. I prefer them to talk it through and talk about what they're thinking so I can get a better understanding of where they're at in terms of their thinking.
Do you formally report on the children's learning?	We use a daily review—each day we review the day using digital photography and documentation of the children's thinking and this is presented for parents at the end of each day. Each child has a portfolio with photos and samples of work that they're doing. We annotate it.
Where do you source your resources?	We have staff meetings where resources are shared and swapped around. Books, internet sites etc. We use the senior part of the school for resources. If they are doing rockets, then we will go and watch them launch their rockets. We have incursion quite often
What approach do you use if a child asks you a question you can't answer?	If they ask me a question, if I don't know the answer I would say 'that's something I don't know about'. We'd get a book often and have a look. We would open the question to the group. That would be the first thing.
Any other comments	I think the other thing is because of the way we do it, there is never a right or wrong answer, the children don't feel worried that they're going to say something that's not right. Sometimes there comes a point where we intervene, but we provide them with examples of what is and try to change their minds.

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Again, there is no specific policy relating to the content of what is taught in the Centre, however, term planning does occur. The children are involved in project work which integrates learning across many areas. Generally a theme will run as long as the children show interest. The staff provide hands-on experiences through which the children can explore, experiment and discover aspects of their world. The children's experiences and thinking is documented and recorded through digital photography. Some of the themes that have run previously include dinosaurs, the skies and colours. In addition, the staff include a range of other science topic areas such as floating and sinking, cooking and observing animals' behaviour.

The staff commented that they avail themselves of science education through Early Childhood conferences and workshops. There was no comment about sourcing additional material, although the teacher felt that she would like to see more science professional development offered as her personal background was in visual arts and she needed support to integrate science 'I don't have a strong background in science at all. It wasn't an area of particular study for me either at school or at university'.

Observation of the centre indicated that it was run in a similar way to other centres. There were static displays for children as well as interest centres with a particular focus.

Example 1—On one of the observation days, which was particularly geared to a science focus, children discussed animals, observable behaviour and animal families. The teacher asked children to group animals by visible characteristics such as presence of horns, number of legs, colour and other features which the children identified. While the teacher used the word 'families' in a scientific manner, it was clear that the children interpreted it in its 'everyday' sense (Fleer, Ridgeway & Gunstone, 2006). They identified two animals of similar breed, called them 'mummy and daddy' and continued to search for a smaller version to use as the 'baby'. The opportunity to clarify the scientific term 'family' was not used. The teacher may have decided that it was too difficult conceptually for the children, or may not have picked up on its incorrect use. As an observer, it was impossible to discern what the reason was. As the activity ensued, one of the children alerted the teachers that there were more animals in one line than another, because they were spread out. There were in fact identical numbers in both lines of animals. The teacher used the opportunity to work on the idea of 'conservation of number' as it had been raised by the child.

Case study Three

Setting:	4 year old group, outer suburban community kindergarten with four members of staff, both assistants with no formal qualifications.
Director:	BEd (Early Childhood), Diploma of Teaching (Early Childhood). Over twenty years of experience.
Teacher:	Diploma of Teaching (Early Childhood)

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Question	Answer
What is your own interest in science and where do you think that came from?	I have science in my undergraduate degree so I find science particularly interesting and believe that children do so also.
When you are completing your program, how do you make the decision on what experiences you will focus on?	It comes from the interests of the children. Children are natural inquirers and therefore science concepts always emerge in the program. We use an integrated approach
When running a science activity, what learning do you look for in the children?	We try to get the children talking about their observations and introduce the scientific language, so we look for their modelling of the language in correct contexts.
Do you formally report on the children's learning?	We keep an individual portfolio for each child which includes samples of work, photos.
Where do you source your resources?	I collect resources/ideas from articles, journals and have made a number of folders around the main science areas. I use a range of books and websites, particularly http://www.familytlc.net
What approach do you use if a child asks you a question you can't answer?	I try to get the child to think by using incidental teaching through focus questions e.g. asking a child to use his/her senses to gather information and think about it
Any other comments	Probably because of my science background, I find science in everything we do. I believe that as a teacher, you can never know enough so I am continually trying to improve things.

This centre does not have a policy on the content that is taught but does have a set of aims and objectives. Science is actively taught and integrated into the whole program. The integrated approach involves:

- Questioning using stems such as who, what, how, when and why;
- The setting up of interest centres such as ice melting, seasonal tables and sensory troughs (a sensory aspect is brought into each activity as much as possible);
- Discussions;
- Experiments (considered to be the best and most enjoyable part) such as volcanoes, popcorn, nutrition, body awareness and anatomy.

Clearly, language and its effective use play a large role in developing children's science understandings.

The teacher had built up an extensive resource of folders of materials as well as children's books and teacher texts covering a wide range of science topics (including environmental, physical, biological and chemical sciences). These resources represent an on-going process and reflect the teacher's comments that 'you can never know enough!' An examination of the folders revealed the focus on science language, particularly correct vocabulary.

The teacher interviewed at this centre was cautious about teaching and explaining concepts of electricity and magnetism in a way that young children understand. However, children at the centre did have access to materials that allowed for explorations of these topics.

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The integrated approach to science could be seen clearly during observations made at the centre. During one session the teacher could be seen interacting with students in a variety of situations each with a substantial science component. For example, the topic of litter was a current focus and when a child found a wrapper blowing along the ground, questions assisted the child to focus his observations. The three elements of literacy (Australian Academy of Science, 2006)—everyday literacy, the literacy of science and scientific literacy were evident during the exchange.

Another exchange involved children re-planting some vegetables that had been uprooted from the garden. The children revisited the conditions needed for the plants to grow, specific vocabulary was used and discussion of observations encouraged.

A variety of interest tables and tubs were set up to encourage and foster children's explorations and the teacher interacted with individuals and small groups through questions and comments. These interactions highlighted the importance of the teacher's role in developing children's conceptual knowledge and skills through the modelling of correct language, including specific vocabulary. This aligns with Vygotsky's (McInerney & McInerney, p38, 1998) socio-cultural theory.

Case study Four

Setting: Suburban, Council Run Long day care and kindergarten centre with fourteen staff two of whom are involved in the Kindergarten Room.
Ass director: Bachelor of Education (Early Childhood)
Assistant: Diploma of Children's Services

Question	Answer
What is your own interest in science and where do you think that came from?	I found that children were intrinsically interested, so I developed my own knowledge to cater for them.
When you are completing your program, how do you make the decision on what experiences you will focus on?	Selection of activities occurs through children's interests. Although not actively planned, incidental teaching occurs through responding to spontaneous experiences. Sometimes relate to outside themes.
When running a science activity, what learning do you look for in the children?	Just interest, and engagement, not really learning as such.
Do you formally report on the children's learning?	We use portfolios of children's work in a range of interest areas.
Where do you source your resources?	We use the natural environment for explorations. Resource books (both children's and adult) and the internet.
What approach do you use if a child asks you a question you can't answer?	I try to ask further questions to get them to think out the answer, then we might look in books or use the internet.
Any other comments	I try to follow a process when engaging children • Establishing an understanding of the process and reasons for it. • Asking questions and assisting the child to make observations. • Children predicting and recalling earlier information from the session and possibly the previous day's observations.

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This centre does have a policy on educational programs but this does not include specific content. Science is taught incidentally through children's interests. This can involve, on a day to day basis, exploring the environment with the children and furthering such investigations by using resource books (both children's and adult) and the internet.

Science is incorporated into the program in various ways. These include, water play, gardening and cooking. Although it is not actively planned, teachers pick up on children's interests and knowledge and use such spontaneous experiences to teach science. This centre did make use of 'outside themes' when these were appropriate. Those mentioned were: Book week; Energy week; Nutrition Week; Science Week.

Observations made during visits to the centre showed the approach to be integrated, with an emphasis on modelling correct spoken language, including vocabulary. An example of the use of children's interests was their engagement in a Space theme instigated by a recent lunar eclipse. The children played in a rocket ship and drew pictures of their ideas about Space. (They were about to add planets to their pictures at the time of the first visit.) Drama was included in the children's explorations as they acted out their experiences of going to the moon, communicating their ideas about what they needed to do and what they were doing. Children were asked questions to stimulate thinking about some of the problems that would need to be solved, for example, because there is no air on the moon what do we need to do? Do we need to bring our own? A lot of resource books were used and the teacher noted that there are now far more written for children than in the past.

During the final visit the topic was *Colour and Light explorations* and it had commenced at the start of Daylight Saving. One experience observed was the use of nature print paper (Solar graphic paper) to produce images of leaves. Children were invited to participate in small groups while their peers could choose a variety of hands on experiences set up around the room or decide on their own play based experiences.

Around the room a variety of light and colour experiences were set up to allow children to explore through play:

- Plastic soft drink bottles with water and food dye in colours representing those of the rainbow. Children place these in front of the sunlight coming in through the window. They have the opportunity to look at the colours shown on the floor as the light passes through the coloured water. Children are encouraged to explore what happens when light passes through combinations of coloured water. E.g. blue and red.
- A light box with Perspex coloured fractions that can be placed on top of the box. The teacher has made clear plastic sheets with fractions traced onto them. Children can use the pieces to complete one whole circle. Language such as fractions is used.
- A set of different shaped Perspex prisms was on display for children to pick up and use when they wish. Children asked questions about why it only works in the sun. The need to be able to move the prism into the sunlight was discussed.
- Kaleidoscopes.
- 'Mirror' tubes (when children look through these they will see an image repeated many times).
- Clear plastic 'keys that can be placed together so that different colours can be seen.
- A table was set up with Ikea photo frames and black and white pictures (nature) in these. There are pastels in shades from white through to black and paper for children to draw 'black and white' pictures.

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All of the experiences provided opportunities for children to discuss their explorations and understandings with peers as well as the teacher. Her use of language was instrumental in focussing children's observations and stimulating curiosity.

Information arising from the interviews

Many teachers felt comfortable with the science concepts incorporated within experiences but did not know how to translate the science knowledge into language that children would understand. Some were concerned about the approach to be taken when dealing with children's explorations of complex concepts such as those associated with magnetism and electricity. For example—How can you explain magnetism without talking about microscopic particles?

DISCUSSION AND CONCLUSION

We were not sure of what we might observe, however Watters, Diezmann, Grieshaber& Davis (2000) have indicated through a previous study, that some concerns might include early childhood practitioners' hesitancy to teach science; this being due to a lack of confidence in their own science conceptual knowledge and understandings. As their research evaluated a professional development initiative, it also identified practitioners' on-going concerns and needs.

In reviewing the four case-studies, it was clear that there were some similarities and some differences across the settings. We were surprised by the amount of specific science experiences being undertaken by staff (at all centres) who had not had science as part of their Early childhood qualification. Despite a lack of training, EC practitioners were attempting to provide children with a range of learning experiences in science. From what we observed and discussed with the EC practitioners, science activities, integrated and stand alone, were a very prominent and obvious inclusion in all centres. We were also surprised at the focus on language development within the science experiences. In some instances there was a strong emphasis placed on the use of 'correct' language, a recognition of the Vygotskian background theories of the importance of language in determining meaning and understanding. That is, that conceptual thinking is not possible without verbal thinking (Nixon and Aldwinckle 2005). In others, this language emphasis was less important than the immediacy of the direction that children were taking the learning. When these directions included play it can be suggested that children's cognitive development was further enhanced, as suggested by the work of Vygotsky when articulating his thoughts on the role of play (Dockett and Fleer 2002).

Where the teacher was confident in her own science understandings, the questioning was more relevant, more spontaneous and usually required deeper thinking on the part of the children. Science experiences evolved out of every outdoor activity—the learning environment was rich in science and associated language. Where the teacher relied more extensively on pre-planned science experiences, only those questions which had been pre-planned were asked and extension of the children's understanding was limited or did not occur.

Some of the approaches seen could be considered in light of the literature on emergent curriculum in which adults observe children and respond to what has been observed. Dockett and Fleer (p198, 2002) note the unpredictable nature of such curricula and describe the role of adults as 'one of focussed observation and responding to the play that occurs in ways that extend and enhance learning'. This can be quite a challenge when confidence in one's own conceptual knowledge and understandings is lacking. All teachers commented on the requirement for more professional learning in science. This has implications for teacher training and professional development.

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In the kindergartens we observed, the EC practitioners also included discrete science activities in the normal routine. For these, the practitioner had prepared the activity and had time to work out the science and so felt comfortable with the children's questions and responses to the activity.

In undertaking the case studies, we have become aware of several issues:

- Practitioners saw a need for science background information both in planning and implementation perspectives—that is, how to respond to children's questions when they are not confident of their own background knowledge. Many saw a need for further professional development in science although simultaneously acknowledging that it was very difficult to find time to attend professional development in any areas.
- Practitioners needed assistance in developing appropriate experiences in a range of specific content areas. It was difficult to recognise whether the content was too complex for the children. For the practitioners there seemed to be no answer to this dilemma as they also indicated that they really needed somebody on hand to guide them.
- Practitioners wanted advice on how to explain scientific concepts to young children in language that was age appropriate. This arose on a number of occasions with some practitioners accepting that some concepts might be too complex for some children to understand whilst others felt that if the concept was couched in simple language, children would understand. The researchers felt that if the science knowledge of the practitioners was stronger, that this might be less of a problem.
- Practitioners wanted on-going support (professional development, resourcing, time, and expert advice) for developing experiences in the science content area. This relates back to the first issues of gaining background knowledge. With time poor circumstances, and many resources being discrete activities for children rather than building practitioners' understandings, there needs to be a different model of professional development provided to practitioners which provides them with this on-going support.

Whilst we can describe what we see occurring in EC centres, it is difficult to communicate what is actually happening. The learning experiences are rich in context and language, although we cannot comment on how the children's science concepts or skills develop over time through repeated or challenging experiences due to our limited observations. EC practitioners believe that children's science experiences are satisfactory, but many also believe that they could be better if they (the practitioners) knew more. Watters, Diezmann, Grieshaber & Davis (2000) have indicated that some concerns which include early childhood practitioners' hesitancy to teach science, may be related to the EC practitioners own lack of confidence in their own science understandings. We didn't observe a problem with the amount of science being taught, rather the missed opportunities for 'incidental' teaching due to perhaps an underlying lack of science knowledge in two out of our four case study participants

While EC practitioners want to increase the amount of science in their programs or to improve what they do, many feel unsure of how to achieve what they want. There are issues with their own science knowledge and how to translate their understandings into experiences and language suitable for young children. They need assistance in developing meaningful experiences that arise from children's own play activities or enquiries. There is obviously a strong need for professional development that addresses the requirements of EC practitioners and sustained resourcing and support.

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SITE ONE	
Questions	**Answers**
Could you explain what approach, if any, you use for addressing science in your pre-school teaching?	Very open ended—children and teacher investigate together. We don't see teachers as having all the answers. Investigations allow us to explore new ideas and concepts rather than answering what we think children want to know.
Is this approach one which taken by all educators in this centre?	Yes
How do the children relate to science when it is presented in this way?	it arises out of the kids interests and their observations and things that come up incidentally
Do you make use of parent helpers in any science activities you undertake?	not generally
Do you assess science understandings, either as a separate area of knowledge or in an holistic manner?	Using questions and observations—Take photos, annotate them, keep in child's electronic portfolio. Science knowledge amongst others.
Could you describe an activity you have undertaken recently which you would call predominantly science focussed?	We did a unit on Growth and development—looking at both plants and animals and discussing growth requirements for living things.

SITE TWO	
Questions	**Answers**
Could you explain what approach, if any, you use for addressing science in your pre-school teaching?	Inquiry approach and children being active participants in experiences i.e. gardening—planting indoors/outdoors. Investigating topics such as light, magnets, cooking experiences, human body, animals/pets
Is this approach one which taken by all educators in this centre?	Generally, although different people have different strengths
How do the children relate to science when it is presented in this way?	They love science—not that they see it as such. It is things they are interested in
Do you make use of parent helpers in any science activities you undertake?	no
Do you assess science understandings, either as a separate area of knowledge or in an holistic manner?	Each day we review the day using digital photography and documentation of the children's thinking and this is presented for parents at the end of each day to look at and reflect on and we also use it with the children to reflect on their thinking and what they thought and how they've moved along with their thinking.
Could you describe an activity you have undertaken recently which you would call predominantly science focussed?	pre-historic animals—arising from children interest, we had an exploratory corner and I did some animal families with them.

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SITE THREE	
Questions	**Answers**
Could you explain what approach, if any, you use for addressing science in your pre-school teaching?	I use an inquiry approach. I tend to present and set up science experiences for the children around selected topis i.e. magnets, light, planting and growing, human body, animals.
Is this approach one which taken by all educators in this centre?	We team plan, so yes…
How do the children relate to science when it is presented in this way?	Children become involved. Usually, the topics arise from the children's play or current interests anyway.
Do you make use of parent helpers in any science activities you undertake?	Sometimes, if they have a particular strength. For example we had a parent who was a musician and she frequently comes and take music sessions with all the children
Do you assess science understandings, either as a separate area of knowledge or in an holistic manner?	Incidental learning throughout our day—drawn from discoveries and children's interests. We annotate their work and keep portfolios for each child.
Could you describe an activity you have undertaken recently which you would call predominantly science focussed?	We talked about natural disasters and children made a volcano in the sandpit. This came from the extreme weather situations seen on the news.

SITE FOUR	
Questions	**Answers**
Could you explain what approach, if any, you use for addressing science in your pre-school teaching?	We involve the children in project work which integrates learning across many areas. We provide lots of hands on experiences, through which the children can explore, experiment and discover about their world.
Is this approach one which taken by all educators in this centre?	Yes
How do the children relate to science when it is presented in this way?	Children love being able to explore and discover things for themselves.
Do you make use of parent helpers in any science activities you undertake?	Rarely.
Do you assess science understandings, either as a separate area of knowledge or in an holistic manner?	Their thinking is documented and recorded through digital photography.
Could you describe an activity you have undertaken recently which you would call predominantly science focussed?	The centre did make use of 'outside themes' when these were appropriate. Those mentioned were: • Book week • Energy week • Nutrition Week • Science Week

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